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CARE AND MAINTENANCE OF TOOL JOINTS

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ENGINEERING PRACTICES MANUAL NUMBER 3

Care and Maintenance of Tool Joints Part 2

Sterling G. Marshall and C. R. Frederick

Page 81

A Quick Look at This Issue

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

☐ **Care and maintenance of tool joints (Part 2) . . .** Drill string failures are costly expenditures for drilling contractors. Thus, it is important to teach field personnel how to break in new tool joints, general rules of tool joint care, proper transportation, and how to correct and minimize corrosion existence. For the most complete manual yet published on this important subject, turn to ..... **Page 81**

☐ **Lisbon anticline: Hottest area in the Paradox Basin . . .** Major Devonian and Mississippian discoveries in the Lisbon area have launched a new era in Paradox Basin drilling activity. Fifteen wells and three dry holes have been drilled or staked since Pure Oil's major discovery in November 1959. For complete details, including two informative maps, turn to .... **Page 89**

☐ **How new underwater oil storage unit works . . .** The California Company has installed a unique 20,000 barrel capacity submersible oil storage unit in Eugene Island Block 110 field off the Louisiana coast. The self contained unit, complete with all producing equipment, was sunk in 35 feet of water adjacent to a well platform. The new battery has mobility comparable to mobile offshore drilling rigs, does not require

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QUICK LOOK *continued*

heavy marine equipment for installation and is as substantial as permanent structures. For complete operational details, see ..... **Page 92**

☐ **Deep gas search sparks South Texas exploration . . .** Stimulated by important new discoveries covering large areas and trends, and by generally satisfactory gas market connections, exploratory drilling is active along deep Edwards limestone and middle-lower Wilcox sand trends extending from Zapata and Webb counties on the Mexican border northeastward about 250 miles to Lavaca County. Farther coastward in the Frio trend, important new gas fields are being found in Hidalgo County, and the lucrative new North Alazan oil field has been devoloped in Kleberg County. Important shallow production continues to be found in south Texas, including oil production at Sacatosa in the Navarro-Taylor in Maverick County, and Queen City gas in Zapata County. For complete coverage of important recent events in Railroad Commission Districts 1, 2, and 4, turn to ..... **Page 97**

☐ **How to complete high-pressure gas wells . . .** Union Texas Natural Gas Company has found 1¼-inch concentric tubing string installations to be the safest means for completing abnormally pressured gas wells (6,000 psi+) in south Louisiana. Kill strings have been installed as deep as 13,600 feet in 43 wells in five fields, and have permitted safe control of wells with tubing pressures as high as 13,000 psi. For an informative case history of Union's experience with these unique high pressure wells, turn to ..... **Page 101**

☐ **Casing failures caused by thermal expansion . . .** Casing strings are normally designed to adequately withstand collapse and/or tensile forces. However, several failures have occurred which are believed to have been caused by thermal expansion. For a detailed discussion of the causes, results, and corrective measures in casing failures resulting from changing temperature conditions, see ..... **Page 105**

☐ **How Conoco made a "non-commercial" field pay . . .** Continental Oil Company has used high volume frac treatments, standard drilling and completion programs, plus a comprehensive automation-data processing system to convert a low permeability, low pressure, solution gas drive field into a commercial success. For an exclusive case history of Conoco's operations in Sacatosa field, Maverick County, Texas, including complete details on the unusual automation system, turn to **Page 109**

☐ **Unique wireline workover converts dual to triple well . . .** Hunt Oil Company has used wireline workover techniques and a pressure actuated perforating gun to convert a two-string dual completion to a triple producer in Brazoria County, Texas. For complete details on this unusual completion, turn to ..... **Page 115**

☐ **Deep Wilcox, Frio, Edwards spur upper Gulf Coast activity . . .** The Wilcox formation is now considered second to the Frio in exploration emphasis in Texas' Railroad Commission District 3, having replaced in Yegua in this category. Important middle and lower Wilcox discoveries near the southwest margin of District 3, and encouraging Wilcox finds in Jasper and Newton counties in the northeast on the Louisiana line are causing increased activity along this trend. Intense interest continues in the Frio trend, with prolific discoveries being made in the coastal counties. Farther up dip, the deep Edwards play becomes more active, spurred by south Texas finds ..... **Page 119**

☐ **How lower Frio changes in depth . . .** The finding of large buried northdipping fault block closures and large gas-condensate reserves in lower Frio sands beneath the gently south-dipping younger section in Matagorda, Jackson and Calhoun counties is one of the most significant events in U.S. Gulf Coast exploration in recent years. For a timely, exclusive report on this promising exploration area, turn to ..... **Page 123**

☐ **How to increase bit weight for less cost . . .** The trend in modern drilling practice is toward higher bit weights. To obtain high bit weights near the surface and reduce tripping time at depth, a new lightweight, high-output applicator has been developed. For a description of the tool, operational advantages, economic advantages and status of the tool's development, see ..... **Page 131**

☐ **Red China claims large oil resources being developed . . .** Red China has increased oil production to 60,000 barrels daily from 2,000 a day 10 years ago. The increase reflects active exploratory and development work in a large country that has extensive areas with good petroleum possibilities. Exploration has been carried out during the decade, over a 500,000 square-mile area. Drilling has involved 11 million feet of hole, including nearly 4 million feet in one recent year. Several older fields have been expanded, and new fields have been found in various regions. China has been aided in its petroleum industry by the Soviet Union, Rumania, Czechoslovakia, Eastern Germany and Hungary ..... **Page 138**

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No matter whether your interest is in exploration, drilling or production, you will find your December WORLD OIL one of the most unusual—and useful—publications you will receive this year.

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- Every item listed will have a code number, with the corresponding number on a postage-paid Reader Service Card. Just pick out the equipment or service you want additional information on, check your preference on the Post Card, tear it out, and put it in your out-basket.

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So, the next time you hear of a subject which would interest you, won't you tell us? Because if you're interested in the subject, more than likely other subscribers will be, too.

on North Africa

Oil Industry in Brief

Here are the latest industry trends, revealed by WORLD OIL and industry research:

Prices hold steady. Markets remained firm through latter part of October, with prices holding at improved levels. Sharply curtailed inventories and other factors should keep prices steady through 4th quarter of 1960 . . . See Page 25.

Demand sluggish. Total demand for all oils was up only 1.2 percent during first 9 months. Gasoline demand was down 3.3 percent in September. However, improved demand is the outlook as colder weather moves in . . . See Page 25.

Exports drop. Oil industry exports have shrunk to slightly over 200,000 barrels daily, only 2.2 percent of total demand. In 1947, they averaged 451,000 barrels daily, 7.6 percent of total demand . . . See Page 25.

New supply up a little. In September, new supply was increased only about 100,000 barrels daily over August, and exceeded September 1959 by less than 100,000 bpd, or less than 1 percent . . . See Page 25.

Crude runs decrease. Runs to stills averaged 8,068,000 barrels daily in September, down 167 bpd from August. However, less than 8 million bpd is considered desirable . . . See Page 25.

Rig activity increases. Active rigs totaled 3,737 on September 30, up 34 rigs over end of August. However, September total was down 384 rigs or 9.3 percent from September's end 1959 . . . See Page 28.

Completions decrease. An average of 129 wells per day were completed during September, down 3 wells daily from August, and down 13 wells daily or 9.1 percent from September 1959 . . . See Page 28.

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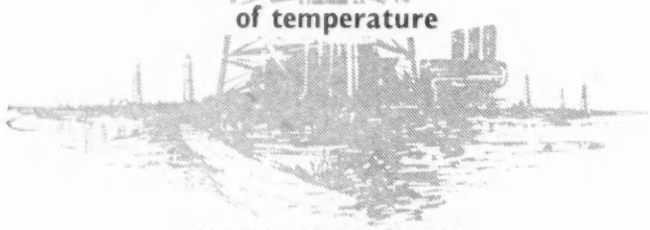

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WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
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PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

Indexed by Industrial Arts Index and Engineering Index

Looking Ahead

The depletion provision . . . an important campaign issue . . . *The oil industry's 27½ percent depletion provision, which has been supported by every Congress since its inception in 1926 has emerged as an important issue in the presidential campaign. Important to the welfare of the nation as well as to the oil industry.*

The two presidential candidates have opposing views, and each is seeking YOUR vote. Of course, the presidential campaign cannot be reduced to just one issue. However, a single issue oftentimes can furnish insight to the philosophy of those seeking political offices.

Quoted below are the statements made by Vice President Nixon and Senator Kennedy before approximately 50 million to 60 million television viewers during their third "great debate" on October 13. WORLD OIL earnestly suggests that you read the quoted statements again, if you've read them previously, to determine which view you think represents the best interests of this nation.

Vice President Nixon says . . .

". . . I favor the present depletion allowance. I favor it not because I want to make a lot of oilmen rich but because I want to make America rich. Why do we have a depletion allowance? Because that is the stimulation, the incentive for companies to go out and explore for oil, to develop it. If we didn't have a depletion allowance, of certainty, I believe, the present amount, we would have our oil exploration cut substantially in this country.

"Now, as far as my position then is concerned, it is exactly opposite to the senator's, and it is because of my belief that if America is going to have the growth that he talks about and that I talk about and that we want, the thing to do is not to discourage individual enterprise, not to discourage people to go out and discover more oil and minerals, but to encourage them and so he would be doing exactly the wrong thing.

"One other thing, he suggested that there are a number of other items in this whole depletion field that could be taken into account. He also said a moment ago that we would get more money to finance his program by revising the tax laws, including depletion.

"I should point out that as far as the depletion allowances are concerned, the oil depletion allowance is one that provided 80 percent of all of those involved in depletion. So you are not going to get much from revenue insofar as depletion allowances are concerned, unless you move in the area that he indicated. But I oppose it. I oppose it for the reason that I mentioned. I oppose it because I want us to have more oil exploration and not less."

Senator Kennedy says . . .

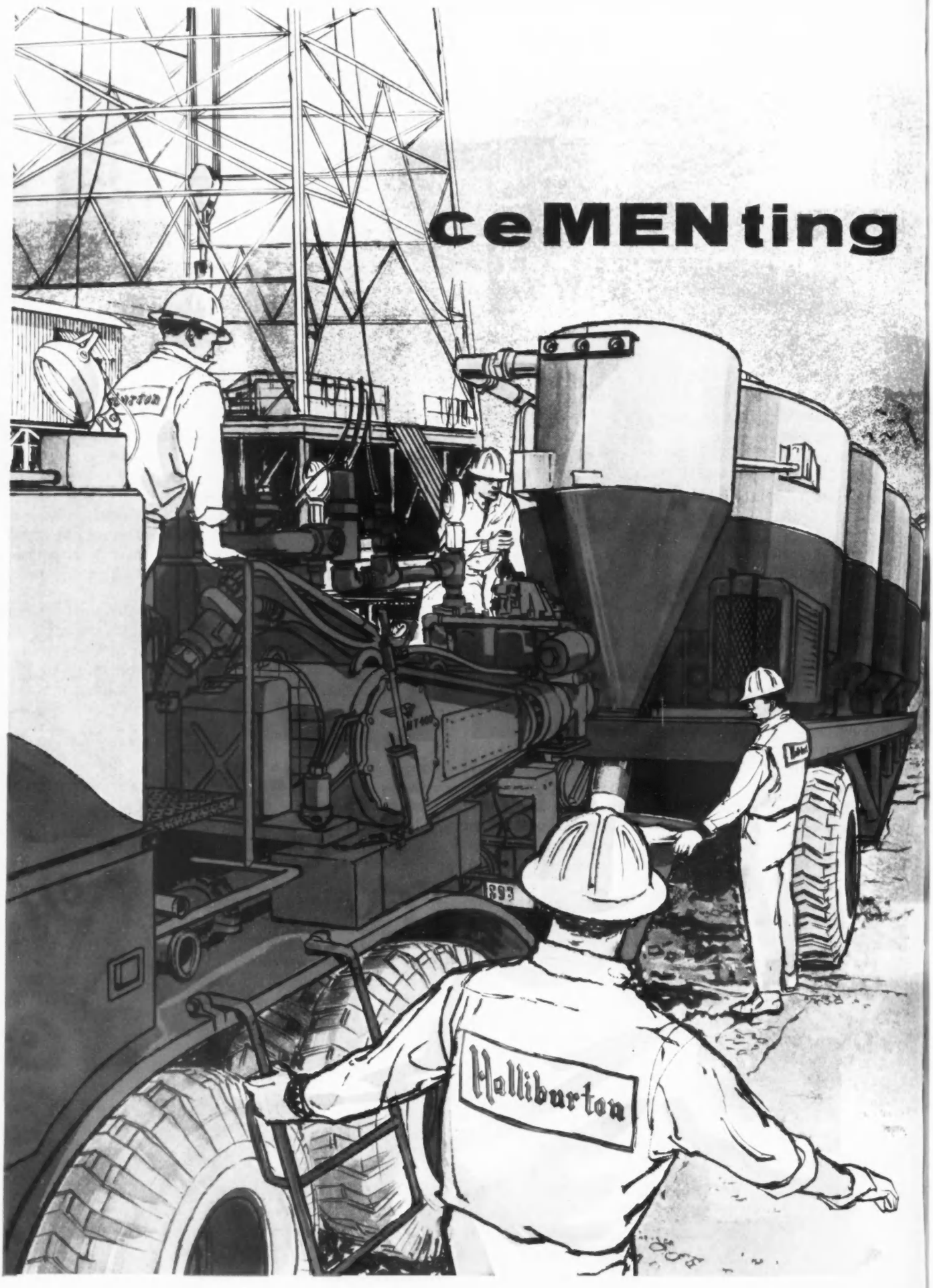
" . . . There are about 104 commodities that have some kind of depletion allowance, different kinds of minerals, including oil. I believe all of those should be gone over in detail to make sure no one is getting tax breaks, to make sure that no one is getting away from paying the taxes he ought to pay.

"That includes oil. It includes all kinds of minerals. It includes everything within the range of taxation. We want to be sure that it is fair and equitable, including oil abroad. Perhaps that oil abroad should be treated differently than the oil here at home. Now, the oil industry recently has had hard times, particularly some of the smaller producers.

"But I can assure you that if I am elected president, the whole spectrum of taxes will be gone through carefully, and if there is any inequity in oil or any other commodity, then I would vote to close that loophole.

"I have voted in the past to reduce the depletion allowance for the largest producers, but for those from $5 million down to maintain the 27½ percent. I believe we should study this and other allowances, tax expense, dividend expenses, and all the rest, and make a determination of how we can stimulate growth, how we can provide the revenues needed to move our country forward."

WORLD OIL reiterates *its often-expressed conviction that maintaining the present depletion percentage provision is to the best interests of not only our nation but also all free nations throughout the world, and to the best interests of every individual in the oil industry and even to every person who ever has occasion to need to buy a single gallon of gasoline!*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The giant that keeps on growing

Because this recent Houston Lighting & Power Company published statement points out clearly and concisely the threat of socialism facing America today, WORLD OIL *is reprinting it in the interest of its readers who, through their considered votes, are the only avenue by which the present course of governmental expansion may be redirected.*

WHAT IS THE BIGGEST business in the United States? American Telephone? DuPont? Metropolitan Insurance? General Motors?

It is none of these.

The largest business in this country owns some 19,000 separate commercial and industrial enterprises and an additional 2,500 defense industries.

It owns 1,205,000 square miles of land, equal to the combined area of Texas, California, Montana, New Mexico, Arizona, Nevada, Colorado, Wyoming and Oregon.

Its holdings include tens of thousands of housing units, plants that manufacture innumerable products, from clocks and chains to paint and dental equipment. It operates motion picture studios, coffee roasting plants, sawmills, printing plants—to mention only a few of its diverse enterprises.

This business operates a vast insurance system that handles one-sixth of all ordinary life insurance in force in the United States. It furnishes electric power to one-fifth of the country's population. It is heavily involved in many phases of banking and mortgage financing.

It is by far the biggest employer in the land, with nearly 5 million people on its payroll.

What is the name of this enormous business? The government of the United States of America.

THE VAST MAJORITY of Americans want no part of socialism, which is simply government ownership of ALL land, business, industry and other sources of wealth.

They are alert and ready to oppose any effort to impose socialism through violence, force or subversion.

Yet, all too few of us really understand the threat that is inherent in the continuing growth of government ownership of land and business, the chief sources of wealth and employment which are the keystones of our American system of FREEDOM.

We must realize that we can drift into socialism—without a revolution or even a vote of the people—by merely allowing the government to continue going into more and more businesses which can and should be operated by free citizens.

WHENEVER THE GOVERNMENT ENTERS A NEW FIELD OF BUSINESS IN COMPETITION WITH ITS OWN CITIZENS, OR EXTENDS THE SCOPE OF AN ALREADY ESTABLISHED GOVERNMENT ENTERPRISE, OUR NATION TAKES ANOTHER DANGEROUS STEP DOWN THE ROAD FROM WHICH THERE MAY BE NO RETURN . . . THE ROAD TO SOCIALISM!

A basic FREEDOM is the freedom to own and operate a business and make a profit. For government to engage in business is a denial of this FREEDOM to its citizens.

TO CHECK the government's rush into business we must:

. . . Participate in political affairs at all levels.

. . . Inform ourselves on political issues and the qualifications and political beliefs of all candidates for public office.

. . . Cast informed votes in all elections . . . votes that will preserve our American FREEDOMS, one of which is the FREEDOM to engage in business.

Only by doing these things can we have a part in preserving our American heritage of FREEDOM.

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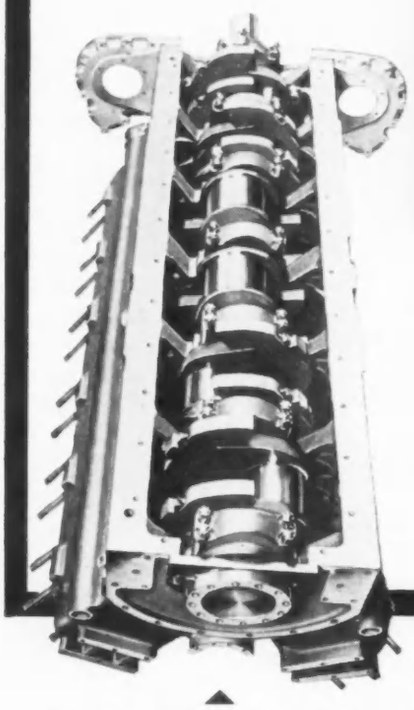
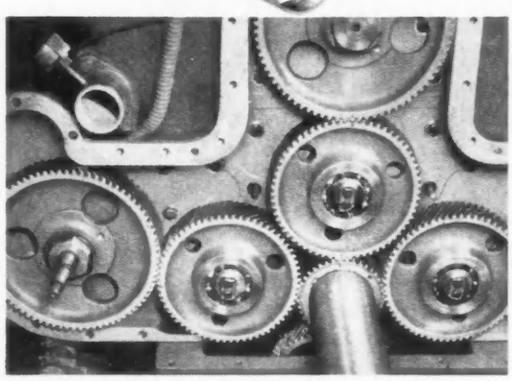


Crankshaft and main bearings in place in a typical Waukesha V-12 oil field engine. Note heavy flanges, thick bearing webs, rugged long-life construction.

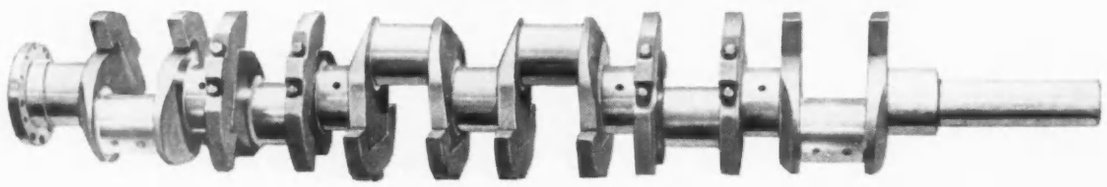
Precision-built and balanced rod assemblies, matched with pistons. Pressure oiled, mirror smooth, heavy pins. Replaceable bearing shells.

Removable wet cylinder sleeves of close-grained alloy iron, finished for oil retention and long life. Heavy duty, aluminum alloy, oil-cooled pistons.



Wide-faced helical cut timing gears are flood oiled. Materials selected for long, quiet life and accuracy. Gears and all elements in the power train, from pistons to flywheel, are precision-machined in Waukesha shops under Waukesha Quality Control.

Rifle-drilled, drop-forged, heat-treated crankshafts, precision-ground to exacting Quality Control standards. Note extra large bearing areas. Statically and dynamically balanced.



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Prices hold at better levels in firm market

Demand for petroleum continues sluggish. But prices are maintained, in hope of better demand ahead, based on colder weather and fourth quarter business

By World Oil Staff

Oil industry markets continued generally steady in the latter part of October, with prices holding at the improved levels attained around mid-year.

Helping to support the markets was the possibility that refining might be curtailed in December by threatened strikes. The Oil, Chemical and Atomic Workers' Union will seek wage increases of 18 cents an hour.

Also bolstering markets is the continuance of strict control of crude oil production. Crude stocks are exceptionally low, and supplies of crude are relatively tight.

Refinery runs have not been greatly excessive lately, although higher than needed or desirable.

Demand for petroleum products has remained disappointing, showing only small gains over a year ago. But sluggish demand has been partially disregarded, apparently in the anticipation of firm markets ahead. Colder weather will stimulate sales of fuel oils, and gasoline could be aided by expected good business generally in the fourth quarter of the year.

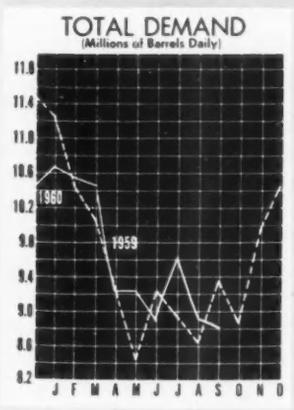
Demand. September was disappointing for the industry from the standpoint of demand for petroleum products. Decreases from September of last year occurred for most products. Those declines pulled down the already slim margins of improvement for the year 1960 over 1959.

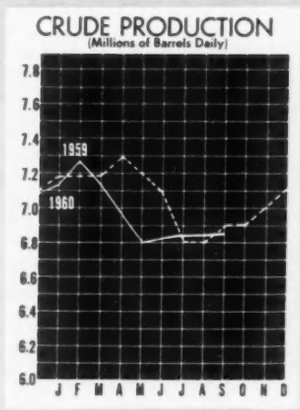
Total demand for all oils in the first nine months of 1960 was up only 1.2 percent over 1959. This was a considerably poorer showing than the gain of 2.8 percent recorded for the first eight months.

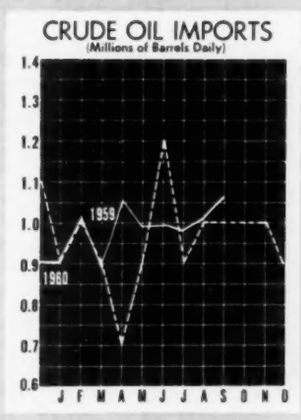
Gasoline, the industry's principal product, now shows an increase of only 1.4 percent for this year over last year. In September the gasoline demand was down 3.3 percent.

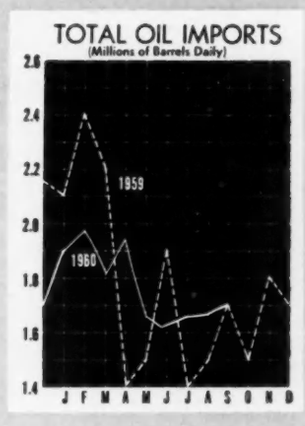
Distillate fuel oil demand so far in 1960 is up 2.3 percent, having been off 10.1 percent in September. Residual fuel oil shows a decrease of 1.5 percent for the first nine months and was off 6.7 percent in September. Kerosine, however, is holding to its

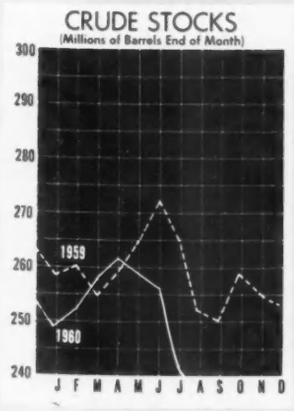
Petroleum Trends...

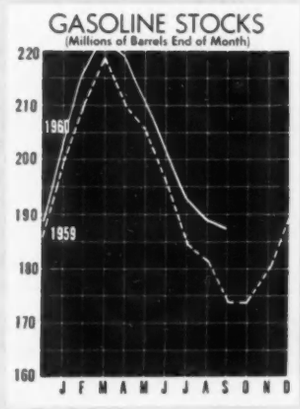


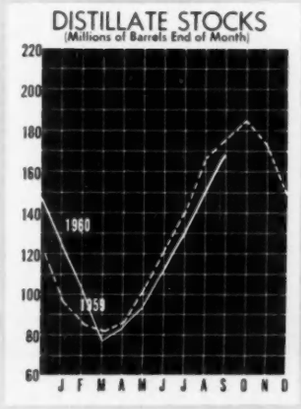


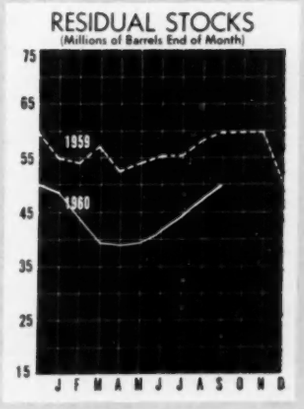












U.S. Petroleum Demand and Supply (Thousands Bbls. Daily)

ITEM	SEPTEMBER 1960	SEPTEMBER 1959	SEPTEMBER % Diff.	August 1960	JANUARY-SEPTEMBER 1960	JANUARY-SEPTEMBER 1959	JANUARY-SEPTEMBER % Diff.
DEMAND							
All Oils, Total Demand	8,817	9,423	— 6.4	8,922	9,662	9,551	+ 1.2
Domestic Demand	8,605	9,196	— 6.4	8,702	9,449	9,307	+ 1.5
Export Demand	212	227	— 6.6	220	213	245	—13.1
Gasoline, Total Demand	4,254	4,401	— 3.3	4,657	4,215	4,158	+ 1.4
Distillate, Total Demand	1,309	1,456	—10.1	1,176	1,786	1,746	+ 2.3
Kerosine, Total Demand	319	267	+19.5	264	333	275	+21.1
Residual, Total Demand	1,236	1,325	— 6.7	1,256	1,560	1,584	— 1.5
Other Oils, Total Demand	1,699	1,974	—13.9	1,569	1,768	1,788	— 1.1
CHANGE IN STOCKS							
All Oils, Change in Stocks	+683	+6	.....	+473	+73	+158	.....
NEW SUPPLY							
Total New Supply	9,500	9,429	+ 0.8	9,395	9,735	9,709	+ 0.3
Domestic Production, Total	7,784	7,724	+ 0.8	7,707	7,916	7,929	— 0.2
Crude Oil	6,859	6,857	.....	6,837	6,996	7,062	— 0.9
Natural Gas Liquids	925	867	+ 0.7	870	920	867	+ 6.1
Imports, Total	1,716	1,705	+ 0.6	1,688	1,818	1,718	+ 2.1
Refined Products	639	722	—11.5	677	798	826	— 3.4
Crude Oil, Total	1,077	983	+ 9.6	1,011	1,020	955	+ 6.8
Crude, East of California	751	745	+ 0.8	666	745	734	+ 1.5
CRUDE RUNS							
Crude Runs to Stills	8,068	7,877	+ 2.4	8,235	8,103	8,017	+ 1.1
Domestic Crude	6,990	6,912	+ 1.1	7,189	7,080	7,068	+ 0.2
Foreign	1,078	965	+11.7	1,046	1,023	949	+ 7.8

U.S. Stocks of Oils (Million Bbls. at End of Month)

KIND OF OIL	TOTAL IN U.S. Sept. 1960	TOTAL IN U.S. Sept. 1959	TOTAL IN U.S. % Diff.	TOTAL IN U.S. August 1960	EAST OF CALIFORNIA Sept. 1960	EAST OF CALIFORNIA Sept. 1959	EAST OF CALIFORNIA % Diff.	EAST OF CALIFORNIA August 1960
All Oils	820.3	832.7	— 1.5	799.8	.....	.....	.....	.....
Crude Oil	231.9	251.0	— 7.6	234.7	217.7	216.7	— 0.5	204.0
Gasoline	187.6	174.1	+ 7.8	189.0	161.4	148.9	+ 8.4	162.1
Distillate Fuel Oil	169.0	174.1	— 2.9	152.4	154.7	158.8	— 2.6	138.2
Kerosine	35.1	31.6	+11.1	33.7	33.8	31.2	+ 8.3	32.2
Residual Fuel	50.4	59.5	—15.3	47.0	33.1	33.1	.....	31.4
Other Oils	146.3	142.4	+ 2.7	143.0	.....	.....	.....	.....

U.S. Crude Oil Production, by States (Thous. Bbls.)

STATE or DISTRICT	Daily Average for Month Sept. 1960	Sept. 1959	% Diff.	Aug. 1960	Total, January-September 1960	1959	% Diff.
Alabama	18.8	13.4	+ 40.3	16.9	5,126	4,139	+ 23.8
Arkansas	78.1	66.8	+ 16.9	81.5	21,544	22,371	— 3.7
California	826.9	840.4	— 1.6	833.3	227,997	256,255	— 11.0
Colorado	131.0	126.3	+ 3.7	131.1	35,268	38,362	— 8.1
Florida	1.0	1.1	— 9.1	1.0	287	354	— 18.9
Illinois	217.8	213.7	+ 1.9	218.6	59,159	65,170	— 9.2
Indiana	31.6	31.5	+ 0.3	32.3	8,646	10,026	— 13.8
Kansas	298.4	326.0	— 8.5	296.9	83,527	99,562	— 16.1
Kentucky	57.0	72.0	— 20.8	57.4	16,234	22,375	— 27.5
Louisiana	1,074.2	979.3	+ 9.7	1,068.5	292,265	290,987	+ 0.4
North Louisiana	110.8	128.6	— 13.8	111.4	33,384	37,594	— 11.2
South Louisiana	963.4	850.7	+ 13.2	957.1	258,881	253,393	+ 2.2
Michigan	41.7	29.5	+ 41.4	41.3	10,495	8,386	+ 25.1
Mississippi	135.6	136.0	— 0.3	134.3	38,265	39,111	— 2.2
Mo.-So. Dak.-Tenn.	0.8	0.6	+ 33.3	0.8	242	83	+191.6
Montana	82.3	84.1	— 2.2	83.2	22,493	25,032	— 10.2
Nebraska	67.9	69.9	— 2.9	66.4	17,953	19,546	— 8.2
Nev.-Wash.-Alaska-Ariz.	1.0	0.8	+ 25.0	1.0	232	191	+ 21.5
New Mexico	288.6	292.6	— 1.4	290.3	80,666	87,590	— 7.9
Southeast	253.3	245.3	+ 3.3	254.5	68,702	75,538	— 9.1
Northwest	35.3	47.3	— 25.4	35.8	11,964	12,052	— 0.7
New York	4.8	5.5	— 12.7	4.7	1,363	1,647	— 17.3
North Dakota	59.4	50.1	+ 18.6	65.5	15,913	14,595	+ 9.0
Ohio	12.4	15.7	— 21.0	12.0	3,647	4,690	— 22.2
Oklahoma	486.9	506.1	— 3.8	484.8	143,003	162,959	— 12.3
Pennsylvania	17.3	17.6	— 1.7	16.9	4,685	5,066	— 7.5
Texas	2,460.2	2,517.2	— 2.3	2,440.2	700,799	823,595	— 14.9
Dist. 1: South Central	44.4	44.0	+ 0.9	43.2	12,071	13,784	— 12.4
Dist. 2: Middle Gulf	105.8	110.3	— 4.1	103.7	31,013	35,962	— 13.8
Dist. 3: Upper Gulf	341.5	350.0	— 2.4	344.0	97,575	116,455	— 16.2
Dist. 4: Lower Gulf	184.3	177.8	+ 3.7	182.7	51,460	58,287	— 11.7
Dist. 5: East Central	26.3	28.6	— 8.1	26.4	17,444	9,139	+ 90.9
Dist. 6: Northeast	242.3	242.8	— 0.2	237.8	67,599	80,493	— 16.0
Dist. 7-B: North Central	128.9	132.5	— 2.7	128.1	35,464	41,674	— 14.9
Dist. 7-C: West Central	115.9	117.7	— 1.5	112.2	33,381	39,094	— 14.6
Dist. 8: West	966.7	977.1	— 1.1	959.3	277,188	322,039	— 13.9
Dist. 9: North	196.5	203.2	— 3.3	194.6	53,485	62,884	— 14.9
Dist. 10: Panhandle	107.8	110.0	— 2.0	108.1	29,707	32,764	— 9.3
Utah	99.6	107.8	— 7.6	94.5	28,318	33,428	— 15.3
Virginia	.....	.....	.....	.....	4	5	— 20.0
West Virginia	6.9	6.4	+ 7.8	6.4	1,710	1,816	— 5.8
Wyoming	358.3	346.2	+ 3.5	357.3	97,204	104.831	— 7.3
Total, United States	6,858.5	6,856.6	.....	6,837.1	1,917,045	2,142,172	— 10.5

Sources for above 3 tables: Bureau of Mines monthly reports, except last two months based on API and B. of M. weekly reports and WORLD OIL estimates, and Texas districts from API.

outstanding gain of about 20 percent over last year.

Exports. The U.S. oil industry's export business has shrunk this year to only a little over 200,000 barrels daily, nearly all being special products. Exports in 1960 have represented only 2.2 percent of total demand.

Exports are now only about one half their volume at the close of World War II. In 1947 they averaged 451,000 barrels daily and constituted 7.6 percent of total demand. That total included 325,000 bpd of products and 126,000 of crude. Crude exports now have virtually ceased.

Supply. Lagging of demand in September threw the supply-demand relationship badly out of balance. New supply was increased only about 100,000 barrels daily over August and also exceeded September of last year by less than 100,000 bpd or less than 1 percent.

But with demand falling 600,000 bpd or 6.4 percent short of last year during September, there was a very large accumulation of products in storage. It contrasted with only a nominal increase in September of last year.

During September, gasoline stocks were reduced slightly. But stocks of kerosine and residual fuel oil were increased substantially, and inventories of distillate fuel oil were expanded by 16,600,000 barrels or 553,000 bpd. The distillate stocks of 169 million barrels on September 30 were close to the 174 million held one year previously, when inventories were considered excessive. Distillate was in oversupply almost throughout last fall and winter, though cold weather in March 1960 finally resulted in the elimination of much of the surplus.

Crude oil stocks were further reduced to 232 million barrels at the end of September, as refiners processed more than necessary. Crude stocks apparently are around minimum working levels.

Consequently, refinery runs in coming months may be held necessarily around desirable levels, with crude production and imports under strict controls. Crude runs to stills averaged 8,068,000 barrels daily in September, down 167,000 bpd from August. But some further reduction, to somewhat less than 8 million bpd, is considered desirable.

...in difficult areas

On the surface, tellurometers accurate to within inches over a fifty-mile traverse are visible indicators of GSI's new look at refraction shooting.

Looking deeper, recently developed refraction interpretation techniques, special refraction instruments and seismometers are giving GSI clients subsurface data in areas where it was unobtainable in the past.

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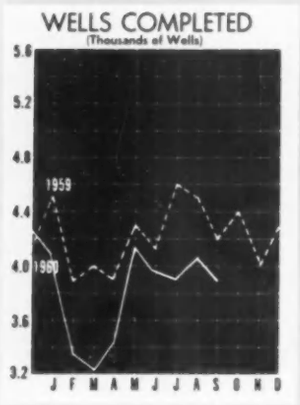
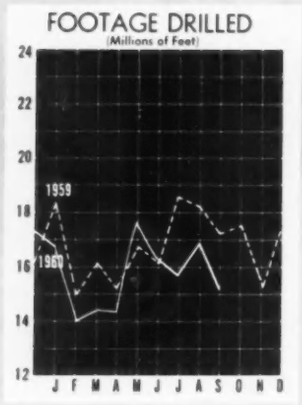
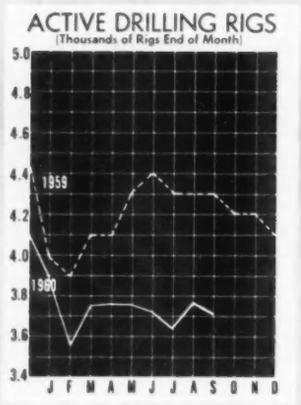
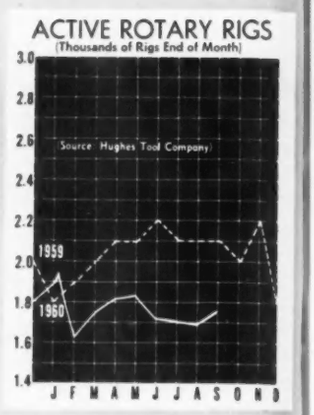
Drilling Activities.









Rig activity increases slightly

By World Oil Staff

Active rigs totaled 3,737 in the United States on September 30, up 34 rigs from the 3,703 reported operating on August 31. However, the September total was down 384 rigs or 9.3 percent from September's end 1959.

Well completions and footage drilled were down in September. Operators completed an average of 129 wells per day, down 3 wells daily or 2.3 percent from the August average —and down 13 wells daily or 9.1 percent from the September 1959 average of 142 wells daily.

Footage drilled averaged 503,333 feet per day, down 11.7 percent from the August average of 551,613 feet daily.

During the first 9 months of 1960, operators completed 34,550 new wells, down 7.9 percent from the same 1959 period and drilled 143.3 million feet of hole, down 7.5 percent.

An average of 26 wildcats per day were drilled during September, down 3.8 percent from the 26 wells per day average in August. The 9-month total of 6,868 wildcats was down 5.3 percent from the same 1959 period.

Summary of U.S. Drilling Activity

ITEM	September 1960	August 1960	NINE MONTHS JANUARY-SEPTEMBER 1960	1959	% Diff.
New Wells Completed:					
Oil	1,788	1,915	16,437	19,262	—14.7
Distillate	56	63	588	623	— 5.6
Gas	371	427	3,123	2,985	+ 4.6
Dry	1,501	1,557	13,514	13,802	— 2.1
Service	147	123	888	846	+ 5.0
Total New Wells	**3,863**	**4,085**	**34,550**	**37,518**	**— 7.9**
Footage Drilled (Millions of Feet)	**15.1**	**17.1**	**143.3**	**154.9**	**— 7.5**

Summary of U.S. Wildcat Drilling

ITEM	September 1960	August 1960	NINE MONTHS JANUARY-SEPTEMBER 1960	1959	% Diff.
New Field Discoveries:					
Oil	43	41	412	537	—23.3
Distillate	5	2	55	72	—23.6
Gas	23	22	194	187	+ 3.7
Total Discoveries	**71**	**65**	**661**	**796**	**—17.0**
Dry Wildcats	**668**	**745**	**6,207**	**6,458**	**— 3.9**
Total Wildcats	**739**	**810**	**6,868**	**7,254**	**— 5.3**
(Percent Productive)	**9.6**	**8.0**	**9.6**	**11.0**	.....
(Percent Dry)	**90.4**	**92.0**	**90.4**	**89.0**	.....

4,800-ft string of X-2 rods begins eighth year in Mitchell #9

In January 1953, Nafco Oil & Gas, Inc., installed 1,800 ft of ⅞-in. and 3,000 ft of ¾-in. Bethlehem X-2 sucker rods, and since then has had dependable rod performance. The well, Mitchell #9, South Liberty Field, near Liberty, Texas, produces 22 bpd of oil, with 324 bpd of water.

The Bethlehem 160-D, series 40 unit pumps at 4,800 ft, in a Yegua formation, with a 64-in. stroke at 16 per minute.

Bethlehem's X-2 rod is ideal for non-corrosive wells, and in wells which are properly inhibited, because it is made from top-quality, carbon-manganese steel. The painstaking heat-treatment (normalizing) assures uniform mechanical properties throughout each rod.

Bethlehem produces four other grades of carbon and alloy rods. The latest of these, Type 41, a high-tensile, manganese-chromium-moly rod, is designed for dependable performance in non-corrosive and effectively inhibited wells.

Information on Bethlehem sucker rods and a full line of accessories is available from your Bethlehem distributor.

BETHLEHEM STEEL COMPANY
Bethlehem, Pa.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

U.S. Drilling Activity in September and First Nine Months, 1960-1959

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR SEPTEMBER, 1960 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Sept. 1960	Aug. 1960	Sept. 1959	Total Footage September 1960	DETAILS FOR JANUARY-SEPTEMBER — NEW WELLS — 1960	1959	% Diff.	FOOTAGE — 1960	1959	WILDCAT DRILLING IN SEPTEMBER AND FIRST NINE MONTHS, 1960-1959 — DETAILS FOR SEPTEMBER, 1960 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY-SEPTEMBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1960	1959	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-down) — Sept. 30, 1960	Aug. 31, 1960	Sept. 30, 1959
Alabama	4	....	....	1	....	5	3	9	58,363	39	83	— 53.0	380,188	745,904	....	....	....	1	1	....	....	....	6	6	27	4	5	8
Alaska	....	....	1	1	....	2	3	1	23,054	13	6	+116.7	144,175	72,967	....	....	1	1	2	1	....	....	4	6	5	8	6	8
Arizona	....	....	....	1	....	1	4	4	6,260	20	19	+ 5.3	56,361	56,055	....	....	....	....	....	1	....	1	16	17	18	7	6	7
Arkansas	23	....	5	28	....	56	42	78	201,641	433	606	— 28.6	1,565,469	2,030,102	1	....	....	8	9	3	1	3	88	95	93	31	32	49
California	68	....	16	30	1	115	126	116	487,818	1,084	1,066	+ 1.7	4,912,719	5,136,003	....	....	....	16	16	6	....	7	202	215	219	133	108	137
Colorado	7	....	9	36	....	52	46	61	261,653	466	554	— 15.9	2,386,490	2,931,147	1	....	1	28	30	13	....	7	214	234	299	85	89	58
Illinois	59	....	....	92	....	151	175	171	329,850	1,451	1,529	— 5.1	3,036,157	3,379,886	....	....	....	55	55	5	....	1	482	488	370	213	248	320
Indiana	44	....	....	84	....	128	130	76	171,122	820	640	+ 28.1	1,108,505	1,019,645	....	....	....	41	41	4	....	....	271	275	177	100	109	97
Kansas	165	....	21	183	15	384	417	373	1,374,768	3,672	3,497	+ 5.0	12,901,445	12,482,777	12	....	8	64	84	67	....	20	562	649	851	245	232	296
Kentucky	131	....	20	85	....	236	251	431	162,916	2,154	2,702	— 20.3	1,730,377	2,280,706	2	....	....	1	3	8	....	1	38	47	66	155	130	206
Louisiana	138	17	19	111	....	285	367	358	2,049,358	2,578	2,844	— 9.4	20,416,642	22,244,066	2	1	....	33	36	25	11	5	348	389	397	329	307	360
North Louisiana	53	....	15	59	....	127	138	142	475,254	954	1,088	— 12.3	3,617,148	3,891,915	1	....	....	18	19	11	....	1	153	165	145	61	56	75
South Louisiana	85	17	4	52	....	158	229	216	1,574,104	1,624	1,756	— 7.5	16,799,494	18,352,151	1	1	....	15	17	14	11	4	195	224	252	268	251	285
*Gulf of Mexico	24	7	2	8	....	41	44	44	395,821	393	356	+ 10.4	4,033,719	3,688,548	....	1	....	1	2	....	2	1	24	27	27	61	59	64
Michigan	28	....	3	41	3	75	94	57	270,078	604	423	+ 42.8	2,217,454	1,292,552	....	....	1	24	25	8	....	3	161	172	108	120	119	99
Mississippi	23	....	5	28	....	56	54	65	551,224	520	485	+ 7.2	5,155,737	4,504,856	1	....	....	19	20	15	....	1	171	187	182	68	51	84
Missouri	....	....	....	1	....	1	....	3	2,990	10	12	— 16.7	26,963	9,901	....	....	....	1	1	....	....	....	1	1	10	....	1	2
Montana	11	....	....	21	....	32	26	22	138,526	215	228	— 5.7	1,065,076	1,094,635	....	....	....	13	13	6	....	2	84	92	66	23	29	52
Nebraska	18	....	....	29	....	47	102	88	255,104	707	642	+ 10.1	3,977,260	3,818,473	1	....	....	22	23	20	....	1	290	311	289	33	27	33
New Mexico	72	....	27	30	4	133	164	152	668,981	1,358	1,290	+ 5.3	6,654,435	5,365,275	3	....	2	15	20	49	....	32	197	278	190	142	150	142
Southeast	61	....	5	21	....	87	106	90	458,998	911	701	+ 30.0	4,665,336	3,347,059	2	....	....	9	11	32	....	10	150	192	132	80	82	80
Northwest	11	....	22	9	4	46	58	62	209,983	447	589	— 24.1	1,989,099	2,018,216	1	....	2	6	9	17	....	22	47	86	58	62	68	62
New York	20	....	6	1	9	36	29	23	47,730	234	207	+ 13.0	391,415	356,295	....	....	....	....	....	....	....	....	....	....	....	25	25	25
North Dakota	15	....	....	10	....	25	18	25	152,172	216	334	— 35.3	1,337,054	2,101,478	1	....	....	3	4	6	....	....	46	52	60	15	14	20
Ohio	52	....	28	29	3	112	93	90	282,993	758	718	+ 5.6	1,840,404	1,931,156	....	....	....	3	3	2	....	6	28	36	21	128	161	218
Oklahoma	187	1	23	117	51	379	424	379	1,136,271	3,414	4,301	— 20.6	12,913,302	15,627,686	1	1	2	25	29	33	6	29	280	348	582	452	416	467
Pennsylvania	25	....	16	6	28	75	70	78	182,142	656	505	+ 29.9	1,817,057	1,608,102	....	....	....	2	2	....	....	5	10	15	19	175	195	177
South Dakota	....	....	....	....	....	....	....	1	....	16	11	+ 45.5	118,391	65,278	....	....	....	....	....	....	....	....	6	6	7	2	4	5
Tennessee	....	....	1	10	....	11	8	3	10,096	67	86	— 22.1	54,385	86,707	....	....	1	8	9	2	....	3	39	44	41	30	35	25
Texas	636	38	89	467	30	1,260	1,212	1,434	5,626,792	11,427	13,322	— 14.2	50,642,017	58,808,448	16	3	7	255	281	122	36	55	2,360	2,573	2,871	838	897	1,029
Dist. 1: South Central	54	1	2	73	....	130	112	68	257,325	835	714	+ 16.9	2,153,601	1,835,226	....	....	....	25	25	3	1	2	243	249	234	38	41	37
Dist. 2: Middle Gulf	10	18	8	26	....	62	65	56	406,752	584	590	— 1.0	3,888,717	3,666,265	1	2	2	17	22	5	11	7	165	188	214	42	52	61
Dist. 3: Upper Gulf	39	8	3	31	....	81	80	94	554,850	853	908	— 6.1	6,084,231	6,518,432	2	1	....	19	22	6	12	3	194	215	210	81	92	97
*Gulf of Mexico	....	....	....	....	....	....	1	1	....	5	2	+150.0	48,184	20,256	....	....	....	....	....	....	....	....	3	3	2	1	1	2
Dist. 4: Lower Gulf-S.W.	30	11	17	33	....	91	86	123	506,898	791	1,021	— 22.5	4,436,387	5,532,529	1	....	1	20	22	10	9	13	231	263	315	62	64	89
*Gulf of Mexico	....	....	....	....	....	....	....	1	....	....	1	—100.0	....	500	....	....	....	....	....	....	....	....	....	....	1	....	....	....
Dist. 5: East Central	2	....	4	16	....	22	13	24	102,929	156	108	+ 44.4	759,695	580,881	....	....	....	12	12	2	1	3	83	89	49	16	22	25
Dist. 6: Northeast	53	....	4	22	....	79	73	66	375,948	646	630	+ 2.5	3,461,896	3,441,848	1	....	....	15	16	5	2	3	129	139	132	82	75	59
Dist. 7-B: North Central	88	....	5	71	5	169	192	207	499,827	1,678	1,813	— 7.5	4,981,748	5,795,500	6	....	2	44	52	40	....	10	476	526	592	79	81	92
Dist. 7-C: West Central	47	....	2	32	....	81	63	67	349,461	601	574	+ 4.7	2,473,302	2,346,329	3	....	....	23	26	13	....	5	164	182	179	52	75	68
Dist. 8: West	149	....	12	56	16	233	267	368	1,663,731	2,321	3,431	— 32.4	13,027,565	17,504,884	1	....	....	44	45	29	....	5	278	312	425	202	194	244
Dist. 9: North	132	....	6	93	9	240	171	244	607,508	2,131	2,619	— 18.6	5,591,745	7,337,549	1	....	....	34	35	9	....	....	340	349	415	125	127	162
Dist. 10: Panhandle	32	....	26	14	....	72	90	117	301,563	831	914	— 9.1	3,783,130	4,149,005	....	....	2	2	4	....	....	4	57	61	106	59	74	95
Utah	5	....	....	5	....	10	17	24	57,648	157	211	— 25.6	893,864	1,174,132	....	....	....	5	5	2	....	6	53	61	56	43	32	34
Washington	....	....	....	....	....	....	....	1	....	2	2	....	12,082	14,458	....	....	....	....	....	....	....	....	2	2	2	2	1	2
West Virginia	28	....	78	17	2	125	106	64	293,274	728	580	+ 25.5	1,844,014	1,479,240	....	....	....	....	....	....	....	....	....	....	1	250	212	124
Wyoming	29	....	4	36	1	70	101	57	313,910	716	603	+ 18.7	3,571,697	3,160,303	2	....	....	24	26	14	1	6	235	256	220	69	54	93
Others	....	....	....	1	....	1	3	2	12,525	15	12	+ 25.0	86,515	71,729	....	....	....	1	1	....	....	....	13	13	7	12	8	7
Total United States	1,788	56	371	1,501	147	3,863	4,085	4,246	15,132,259	34,550	37,518	— 7.9	143,260,650	154,949,962	43	5	23	668	739	412	55	194	6,207	6,868	7,254	3,737	3,703	4,184
Total Western Canada	120	....	23	41	....	184	243	193	1,031,380	1,842	1,868	— 1.4	10,042,643	9,242,843	....	....	....	....	....	....	....	....	....	....	....	158	173	184

* Gulf of Mexico wells are included in their respective district totals.

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Photo: Petroleum Engineer E. Ralph Daniel, Assistant Vice President Herbert F. Poyner, Jr., Vice President Frank E. McGonagill, Jr. on location.

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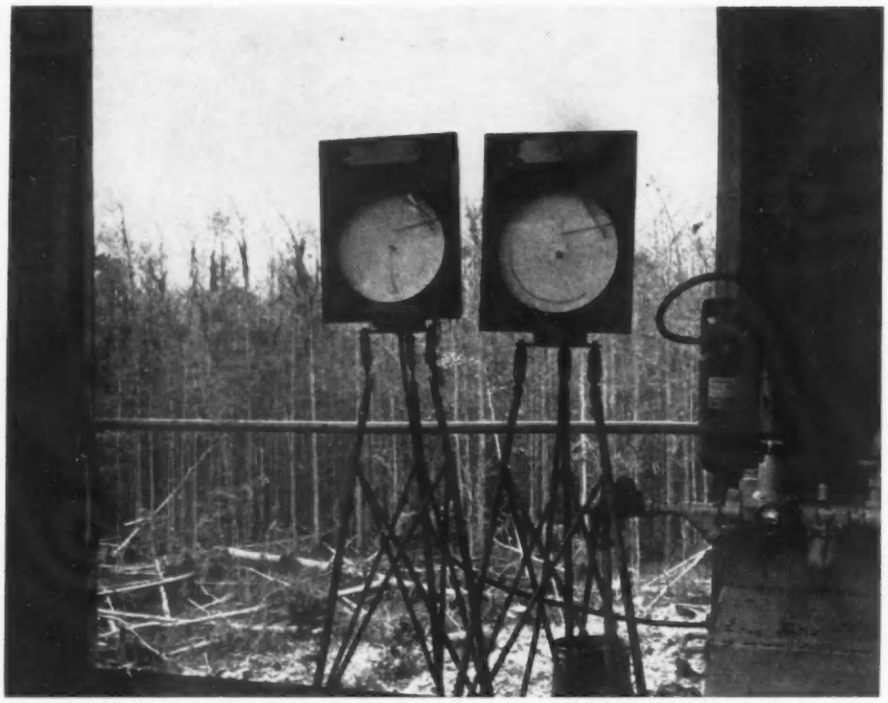
Practical Operating Hints

These How-To-Do-It Ideas Can Save You Money



How to Snub Chart Vibration

Since the twin mud recorders must be mounted on the derrick floor where they can be watched by the driller, they are subjected to vibration always present during drilling operations.

The recorder unit has a three-spring suspension, the base of the recorder being mounted on the three coiled springs which, in turn, are attached to the three tips of the tripod stand.

When rig vibration coincides with the period of the springs, the recorder will oscillate so seriously that it may affect readings as well as visibility. To curb this motion, wrap the three coil springs with ordinary tire or insulating tape. This effectively dampens out the oscillations, while not interfering with the shock-absorbing qualities of the method of mounting. In the illustration, the springs on the suction chart are as furnished, while those of the pit unit are damped. A single wrap of tape is sufficient to curb the vibration, while too heavy a wrap might check spring shock absorption.

Portable Lease Pump Built Economically

This independent producer found waterflooding operations were causing high tank bottoms to accumulate rapidly. Tank cleaning became a regular chore and a discarded one-foot bottom was costing $36 per tank. The portable pump unit shown was constructed to circulate these bottoms and recover income previously lost. Total cost of the unit was $110 excluding the 9 horsepower air cooled engine.

The front half of a 1939 automobile frame and wheels was purchased for $7.50 and a 1949 three-speed transmission for $10. A new two-inch pump was purchased for $65 and two flexible couplings, bolts, etc., accounted for the balance. The front axle was lined up and welded solid, and a piece of 5-inch channel iron was welded across the front of the car frame. A piece of 2-inch pipe was welded to the channel iron and to the back of the frame to make the trailer tongue. Engine transmission and pump then were mounted on used 4-inch channel iron five feet long which were taken from an old pumping jack.

Three-sixteenths inch or ¼-inch plate steel supports were used for the transmission at both ends. The splined hub from an old clutch disc is centered on one half of the engine coupling and mounted with four cap screws. The transmission half of a discarded universal joint adapts the rear of the transmission to half of the pump coupling. Hacksawing the two arms off close to the body of the U-joint allows it to be slipped on the splined shaft at the rear of the transmission. This leaves a smooth machined surface extending outward on which to mount half of the pump coupling. Since the rear of the transmission is not sealed an oil drain hole was drilled in the transmission "neck" with ⅜-inch copper tubing carrying oil to the bottom of the transmission.

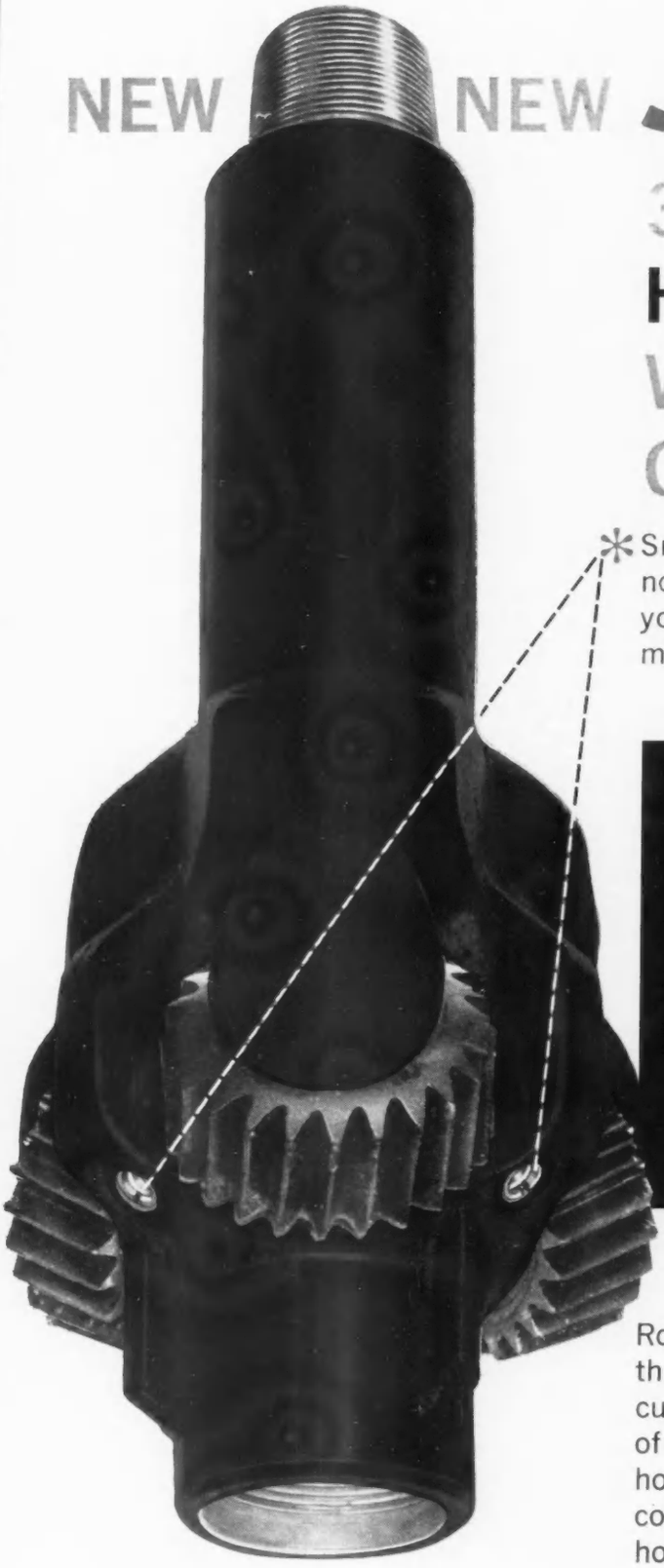
How to Protect Weight-Recorder Leads

The two flexible leads to and from the weight recorder can be, and usually are, run under the derrick floor, except for the short span where they tie into the pressure sensing device at the tie-down.

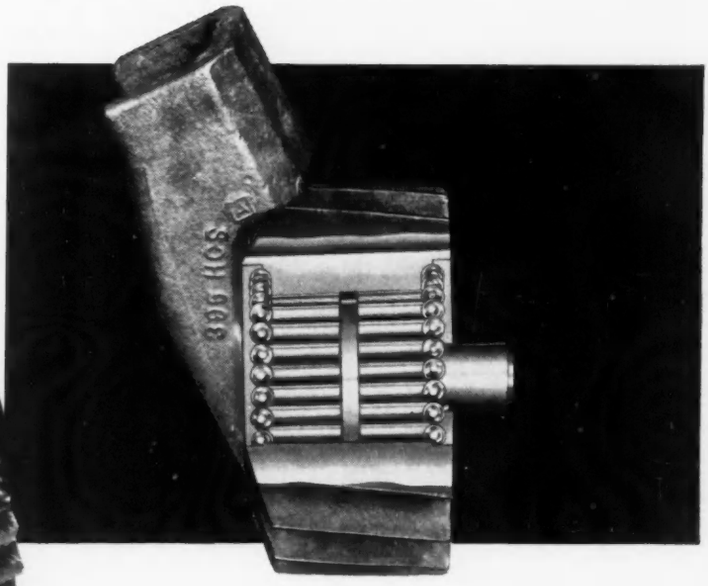
By splitting a short section of 4-inch pipe and welding one end to the frame of the tie-down, the half-pipe will form a shield over the exposed leads and effectively protect them in case anything is dropped in the area. The shield protects but does not hide the flexible leads, so they may be readily inspected in case a leak is suspected.

NEW NEW *Smith*

3-POINT HOLE OPENER WITH JET CIRCULATION



* Smith field-proven threaded flow nozzles are easily installed and give you maximum jetting action with minimum pump pressure.



Supplied with DIAMOND POINT or BULL NOSE PILOT, or you can use your own dull rock bit.

Exclusive SMITH feature:

Roller bearings on the shaft and ball thrust bearings on both sides of the cutter prevent tilting and wobbling of the cutters, insure true, full gage hole and trouble free running. This construction is found in no other hole opener.

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Install Extra Toolbox On Pumper's Truck

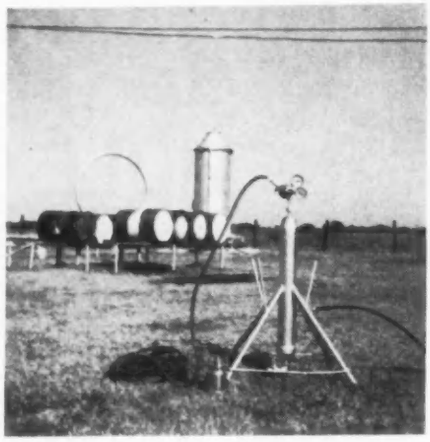
A small toolbox, 4 inches high by 15 inches long by 4 inches wide, may be bolted to the running board inside most late model pickups. Small hand tools (crescent wrenches, choke cleaners, choke wrenches, etc.) used most frequently during well servicing are placed in this box while the pumper is making his rounds. This saves time and many trips to the larger tool box behind the cab.

Speed Rigging Up Time With Adjustable Supports

Where the engine and drawworks subbase must be placed on uneven ground, a telescoping set of legs will make it easier to rig up and level the derrick floor. The inside pipes in the illustration have holes every two inches and the upper beams can be leveled and then the pins inserted in the holes. When it is time to rig down, the hinged bases fold into a flat load.

Use Portable Drip To Supply Spray Gun

This portable scrubber is used to supply gas to paint spray guns and pressure type cleaners. The drip is made of junk 3-inch pipe with welded caps on each end. One-fourth inch outlet and ¼-inch inlet connections are provided as shown. A pressure reducing regulator is installed on the outlet connection. A ½-inch drain is installed in the bottom. Legs are constructed of one-inch pipe with ¼-inch rods attached vertically. These



¼-inch rods are used as guides for the spray gun hose. When moving, the hose is coiled around the drip with the guides, thus enabling one man to load, move and unload the unit easily.

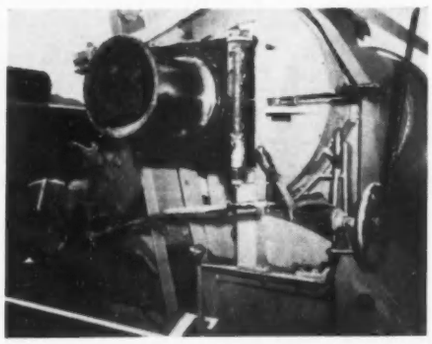
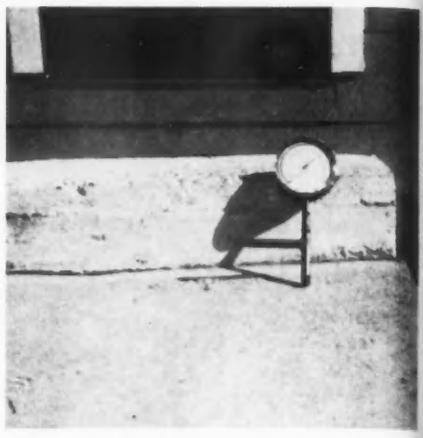


Plate Behind Cathead Prevents Catline Fouling

On older model drawworks, it is possible for the catline to fall down between the cathead and the drawworks and present a dangerous situation to the roughneck and perhaps damage the catline. On the outside of the plate a roller is installed to further keep the line out of the space and prevent wear on the catline.

It was found that a 12-inch male casing thread protector would fit over the lip of the cathead when it was cut in two and rewelded around the inside end of the head. The protector was then cut down to width of 1½ inches and welded to the plate so that it could easily be fastened to the side of the drawworks. The plate then slips under the roller which is mounted on the side of the drawworks.



Prevent Test Gage Damage By Using An Adapter

To save the threads on test gages, an adapter may be used to advantage. A handle also is used so that wrenches need not be applied for tightening. The adapter shown is made from ½-inch pipe. The vertical portion is approximately 12 inches long and has a collar welded on one end to receive the gage. The horizontal handle is about 10 inches long. The whole unit is installed when test pressures are required, thus subjecting the threads on the adapter to all wear and tear. Gages stay in calibration longer and threads remain in good order since the gage must be installed on the adapter only one time.

Secure Blowout Preventer Extension Arm

The extension arm for manually closing the rams on the blowout preventer is very cumbersome and should be adequately secured.

A Gulf Coast contractor has taken a 1-inch piece of steel and welded a right angle piece to one end and a 2-inch nipple to the other. The handle is taken off and this device is slipped over the extension arm and then welded to the sub-structure I-beam.

From TOP to BOTTOM

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DRAW WORKS
ENGINES and MOTORS
SLUSH PUMPS
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SWIVELS
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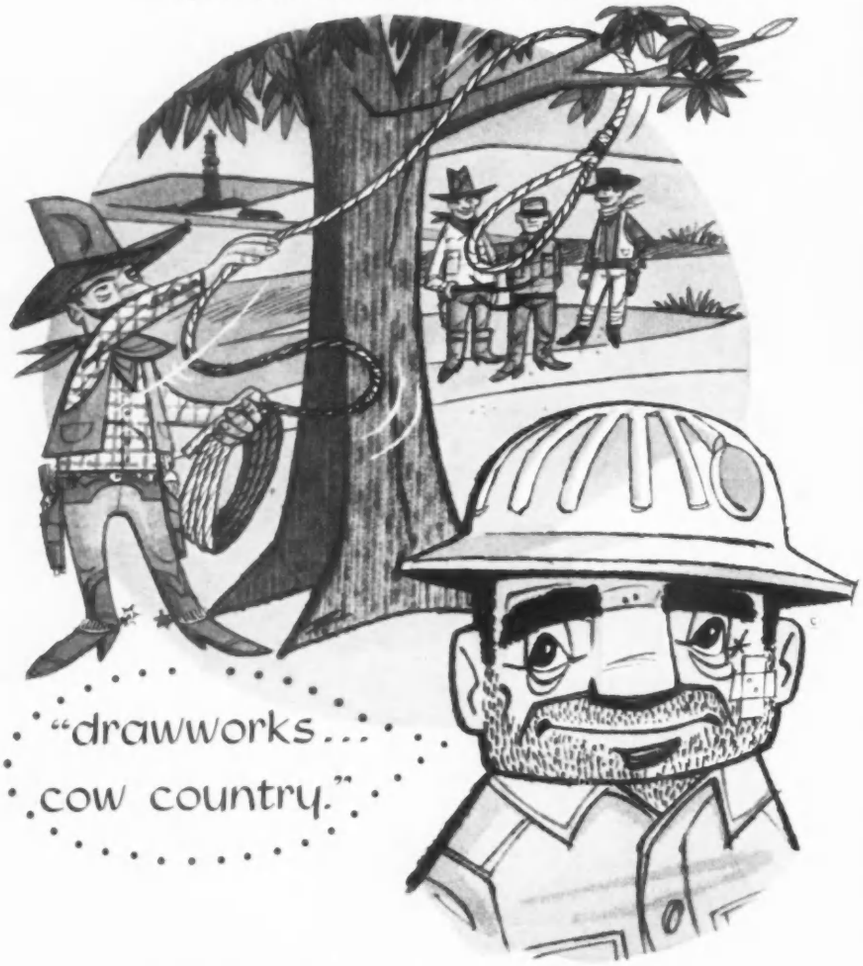

Joe Roughneck, backbone of the oil and gas industry, sees many a truck of tough Lone Star pipe roll onto well locations from the bayous of the Gulf Coast to the plains of the Williston basin. He knows delivery will be *on time* because Lone Star pipe is stockpiled . . . in quantity . . . in the heart of the oil country.

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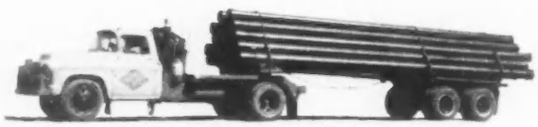

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Sump Around Tank Makes for Neat Battery

This operator has constructed a narrow sump around the circumference of each stock tank in the battery. Scrap tank steel is cut and bolted as shown. Gravel then is used to fill the space between the steel and the tank. Oil dripping from the gage glass or spilled from the tank is retained in the sump and the lease is kept clean at all times.

Device Raises/Lowers Reserve Pit Jet

It is necessary at times to raise or lower the jet in the reserve pit. Here is shown where a contractor uses two pieces of timber (8″x8″x6′), a length of scrap 4½-inch drill pipe, and about 10 feet of rope to accomplish this feat.

To assemble this device, place the two timbers on two opposite banks of the reserve pit; lay the pipe across the pit with the pipe resting on the timbers. The rope should be coiled around the pipe toward the center and one end of the rope connected to the jet. The jet can then be lowered or raised by twisting the pipe.

2. CARE AND MAINTENANCE OF TOOL JOINTS

By Sterling G. Marshall, Tubular Products Engineer
C. R. Frederick, Administrative Assistant, Reed Roller Bit Co.
Houston

DRILL STRING EXPENDITURES can be minimized by taking precautionary measures of preventing trouble before it occurs.

Continuing emphasis should be placed in maintaining proper care and handling of tool joints and drill pipe in the field. This program may be applied to new pipe and its proper breaking-in procedure as well as to the handling of pipe that has drilled several feet of hole.

Thus to better understand how the life of drill pipe may be extended, this section of the Engineering Practices Manual No. 3 on Care and Maintenance of Tool Joints will discuss the following:

- Equipment requirements
- Rules for care and handling
  - A. Breaking-in period
  - B. General rules of care
  - C. Transportation and storage
  - D. Corrosion

EQUIPMENT REQUIREMENTS

1. Plan the drilling string to permit good operating practices.

Select a drill pipe string to keep maximum possible tensile stresses within allowable limits even when fishing. In most cases, this is no real problem, since conventional strings of Grade D or E drill pipe afford an excellent safety factor. However, if planning deep drilling (below 15,000 feet), consider the new high strength grades, or heavy weight grade E pipe.

Use sufficient drill collars to keep the drill pipe in tension (see Appendix IV, December WORLD OIL), thus keeping the "neutral point" of the string always in the drill collars. This will minimize the effects of some causes of drill string problems: Among these are:

(1) Rapid pipe and tool joint wear.

(2) Crooked pipe and eccentric O.D. wear which results from it.

(3) High connection stresses which result from inadequate make-up torque or crooked holes.

(4) Corrosion fatigue in tool joints which starts from the bore and progresses outward.

2. Keep mechanical equipment, particularly automatic catheads, in top working condition at all times.

3. Have available a good torque gage for checking catheads and insuring the use of recommended make-up torque on connections.

4. Use only a good grade thread lubricant. One recommended type is 40 percent-60 percent zinc base. This type employs a base of 40-60 percent finely powdered metallic zinc. Lead, Copper and other metallic base compounds are good, as is molybdenum disulfide. Purpose of the metallic base is to preclude the possibility of forcing all the lubricant from between the mating thread flanks and shoulders because of the extremely high loads or pressures between the surfaces of the mating pieces.

5. Keep thread protectors for all pins and boxes for the entire string of drill pipe and drill collars, and for miscellaneous subs on the rig.

RULES FOR CARE AND HANDLING

Breaking-in period. A new tool joint connection should be "broken in" with care, as is recommended for any piece of the fine machinery. The initial make-up is most critical. The exact length of time the break-in period takes has not been determined, but special care should be exercised for the first 5 to 10 times each individual joint is made up.

The following steps are recommended for picking up a new drilling string:

1. Remove rust preventative or other protective coat-

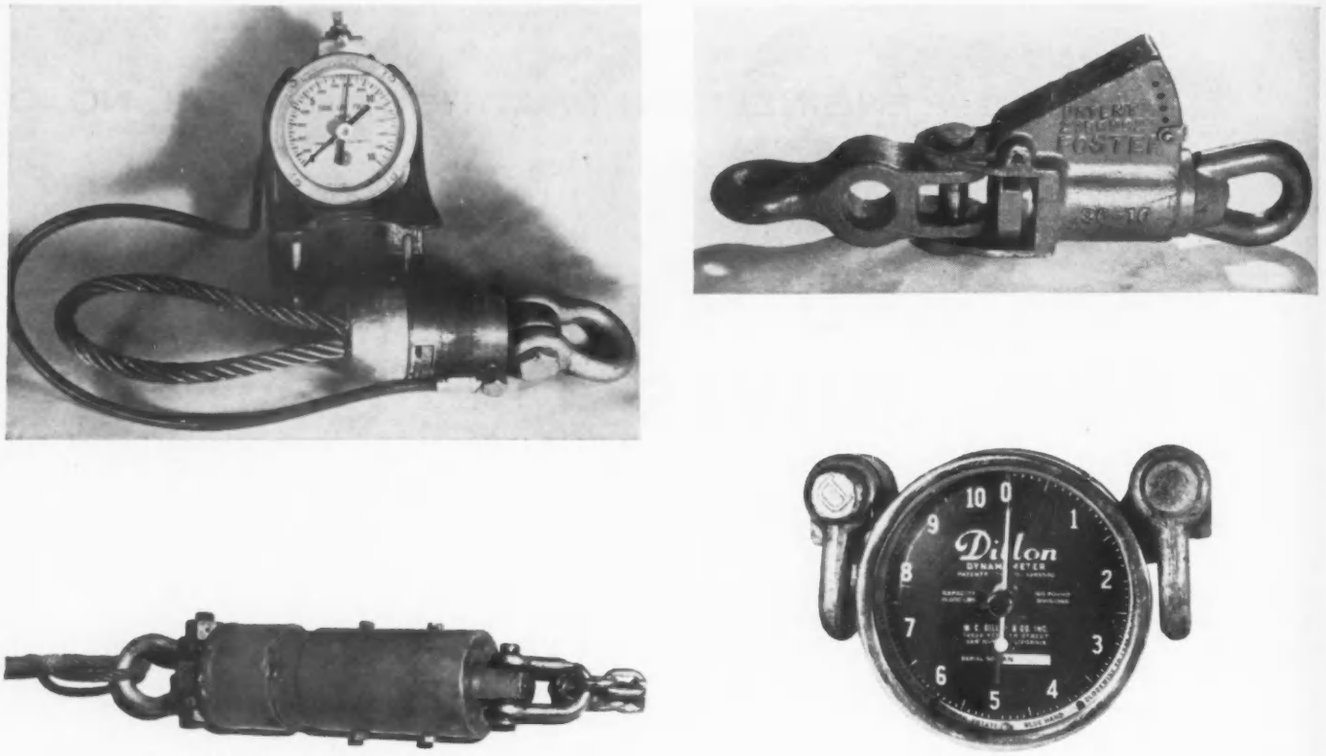


FIGURE 28—Some commercially available tong torque gages.

FIGURE 29—Remove rust preventive and clean joints before using.

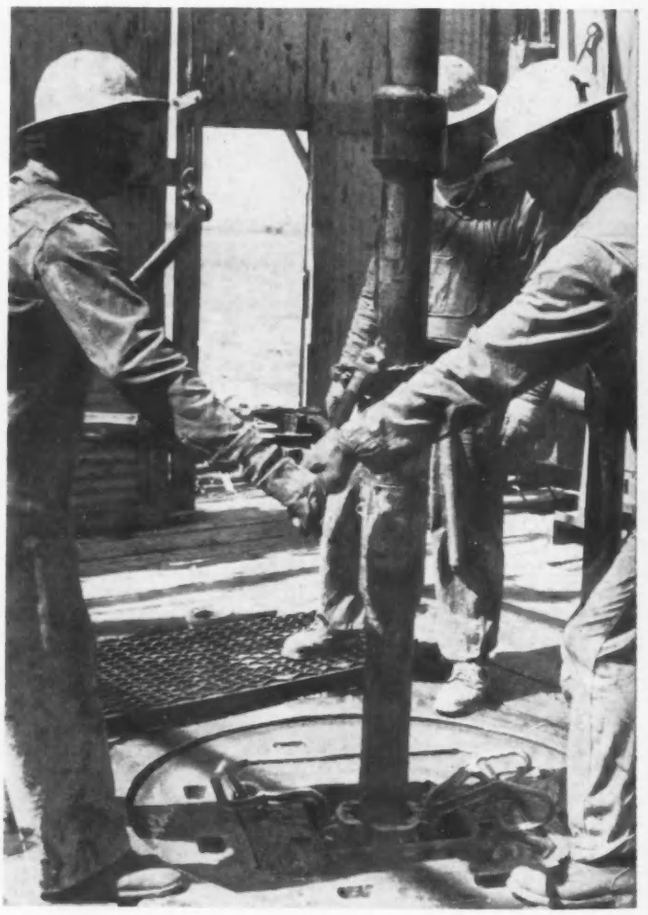


FIGURE 30—Hand-tong new tool joints for first trip.

FIGURE 31—Keep derrick floor clean.

ing from connections with bristle brush and solvent, or steam clean.

2. Visually inspect threads and shoulders for damage—do not pick up any of doubtful condition—repair or clean as necessary, before using.

3. Replace pin thread protector before pulling in on walk and hoisting to derrick floor.

4. Wipe pin and box clean and dry before applying lubricant.

5. Apply adequate thread dope to all surfaces of pin and box threads and on both shoulders of the connection.

6. Stab pin into box with extra care—avoid hitting box shoulder with end of pin.

7. Hand tong connections on initial make-up—do not use spinning chain.

8. Using a tong torque gage, make-up each joint to the recommended torque for the specific connection, as shown in Appendix I (WORLD OIL, October 1960, Page 117, Care and Maintenance of tool joints, Part I).

During subsequent break-in trips, it is not necesary to wash lubricant from connections unless there are indications of damage or developing trouble. Normal "doping" procedures (applying only to threads and shoulders of box) can be followed, and the spinning chain can be used for make-up, but joints should be spun slowly. Continue using the tong torque gage to make up the connections with recommended torque.

General rules of care. Following the critical break-in period, proper care and operation of the drilling string are still essential to obtain maximum trouble free service life.

Serious troubles will generally give early warnings: connections difficult to break, "dry" pins, or small shoulder and thread galls. If immediate action is taken to find what is causing the problems, and steps taken to correct conditions, any real problem can be averted. If the early warning signs are ignored, failures of an "epidemic

FIGURE 32—If necessary to jack stand into position, use a special jacking tool with a soft nose of brass or bronze.

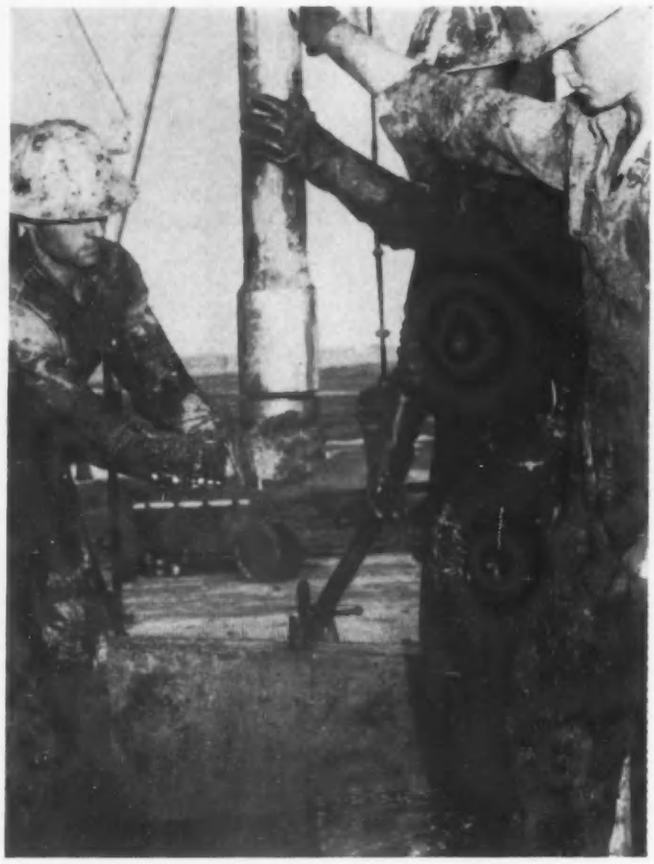


FIGURE 33—Install thread protectors before laying down a joint.

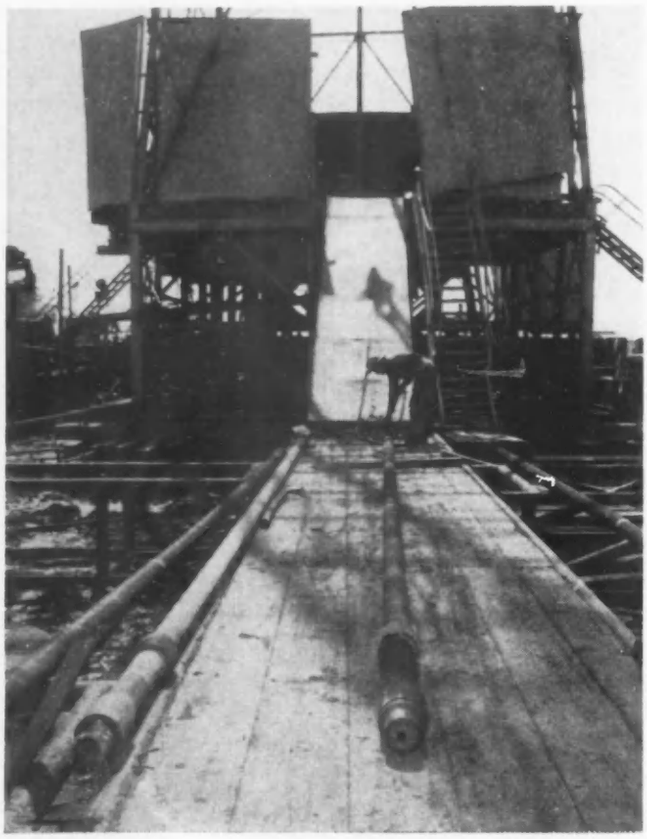


FIGURE 34—When laying pipe down, keep walk clear. Do not allow joint coming down to hit another joint or other object on walk.

FIGURE 35—Clean and inspect kelly sub regularly.

nature," that is, a series of failures within a relatively short time, are likely to develop. These can be expensive, causing fishing jobs or at best a costly repair bill.

The rules of care which follow, if adhered to, will minimize the chance of any failures.

1. Keep the kelly sub in good condition. The pin thread mates with every tool joint box in the string, and an entire string can be damaged quickly if the kelly connection is damaged or dirty.

A. Inspect and clean the sub every time it is removed from the rathole. If damage is found, repair or replace the sub immediately.

B. Keep a spare kelly sub with a new thread on the rig at all times. This will eliminate the necessity of using a damaged sub.

2. CHECK THREADS OF EACH JOINT BEFORE ADDING TO STRING . . . NEVER ADD ANY WITH DAMAGE . . . FINS, BURRS, GALLS, ETC. REPAIR BEFORE USING THEM.

3. Lubricate the box (threads and shoulders) with a good grade of thread lubricant. Keep lubricant and applicator clean and free from dirt.

4. Stab pin into box with care. Avoid striking box shoulder with end of pin.

5. Before spinning up, be sure connections are in alignment. Don't rotate too fast . . . if joint wobbles and binds, high speeds can "burn" threads.

FIGURE 36—Keep thread protectors on pins when bringing in from walk.

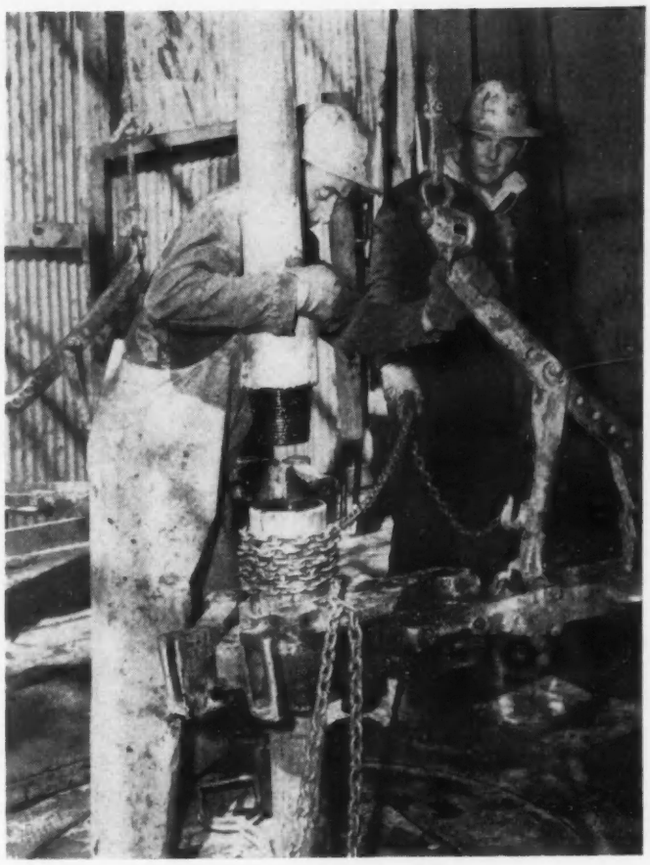


FIGURE 37—Stab pin into box with care.

The connection should make up with spinning line to shoulder, such that only about a 30° - 45° movement of the tong is necessary to tighten. If more is required, the joint should be checked for cleanliness or damage.

6. Using tong torque gage, make up with tongs to recommended torque. Use both make-up and back-up tongs on the tool joint . . . NEVER ON THE PIPE. (If torque gage reads in pounds, multiply by length of tong arm to get make-up torque in pounds—feet.

7. When pulling out of hole, be alert . . . watch for crooked pipe, loose or leaking joints and other indications of trouble.

8. When breaking out . . . use both tongs on the tool joints.

9. After breaking connection, rotate out slowly, with just enough tension on the hook spring to keep minimum pressure on the disengaging threads, but enough to avoid any possibility of the end of the pin striking the box shoulder. Watch for dry joints or mud on threads, which can indicate damaged connections or insufficient make-up torque.

10. When standing pipe back, be sure rig floor is clean. If perfect positioning of stand is not achieved on the floor, DO NOT USE WRENCH OR OTHER SHARP EDGED TOOL TO "JACK" INTO POSITION . . . SHOULDER DAMAGE COULD LEAD

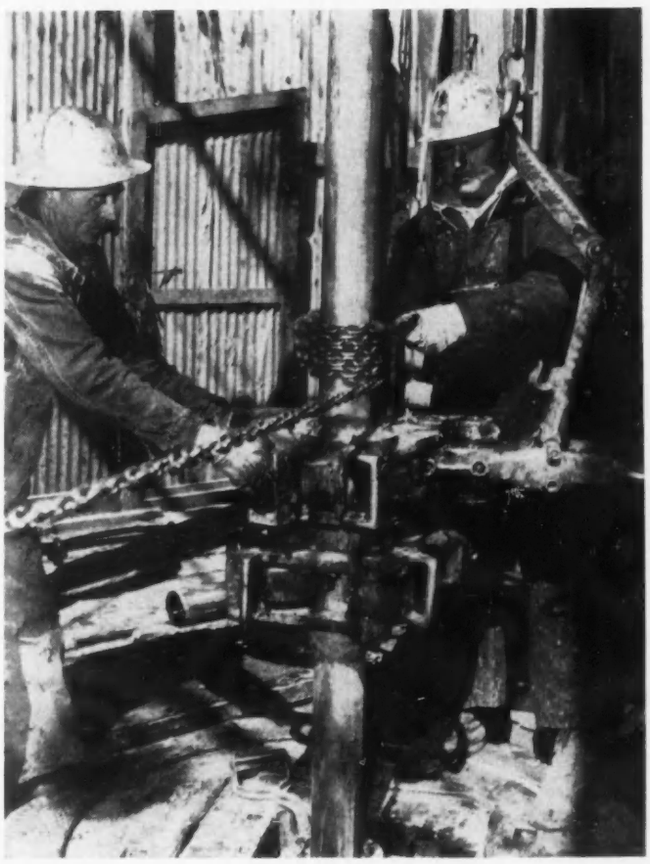


FIGURE 38—Spin up slowly; use make-up and backup tongs.

FIGURE 39—Washing joint of pipe with clear water before laying down.

FIGURE 40—Apply rust preventive before moving and storing pipe.

TO SERIOUS TROUBLE; USE A SPECIAL JACKING TOOL WHICH HAS A SOFT NOSE MADE OF BRASS OR BRONZE (THIS CAN BE FABRICATED FROM A PIECE OF PIPE AND A DISCARDED WRENCH WITH BRAZING ROD APPLIED TO THE NOSE WHICH ENGAGES THE TOOL JOINT SHOULDER).

11. When laying down pipe, install thread protector before swinging through "V" door and onto walk. Keep walk clear . . . do not allow joint coming down to hit another joint or other objects on the walk.

There is no substitute for a good crew. A good one automatically follows the recommended practices, but still makes a trip as fast as a poor one which cuts all the corners. It is a matter or coordination, the same as required for any successful team, whether on a drilling rig or on an athletic field.

Transportation and storage. A little extra time taken when pipe is being moved or prepared for storage can pay big dividends in future trouble free service and reduction of maintenance costs.

1. When laying down pipe, wash tool joints and pipe internally and externally with clear water. This will remove any salt or other corrosive agent which might bring about more rapid deterioration.

2. Apply a rust preventive compound to threads and shoulders, particularly if pipe is to be stored for any length of time.

3. Be sure thread protectors are installed on boxes and pins and are tight.

4. Check pipe for straightness and straighten, if needed.

5. When racking, use wood or wire rope spacers between layers. Three spacers are desirable . . . one in the center and one close to either end behind the tool joints. Spacers should be thick enough to keep tool joints separated when rolling pipe.

Corrosion. In many areas, corrosive conditions are encountered which materially affect the performance of the drill string. In general, the corrosive conditions are a problem for the mud engineer, but in many instances he is limited in what he can do. Prevention of downhole drill string problems arising from corrosive conditions can best be combatted by having alert personnel who watch for potential trouble development and report it.

Causes. There are four main possible causes for corrosion:

1. Presence of salt in formation or drilling fluid.

2. Bacterial action on certain materials in the drilling mud.

3. Presence of air, free oxygen, and/or carbon dioxide, in the drilling fluid.

4. Presence of hydrogen sulfide.

Effects. Regardless of cause, there are certain general effects of corrosion:

1. Pipe and tool joint become pitted.

2. Fatigue cracks start in the pits.

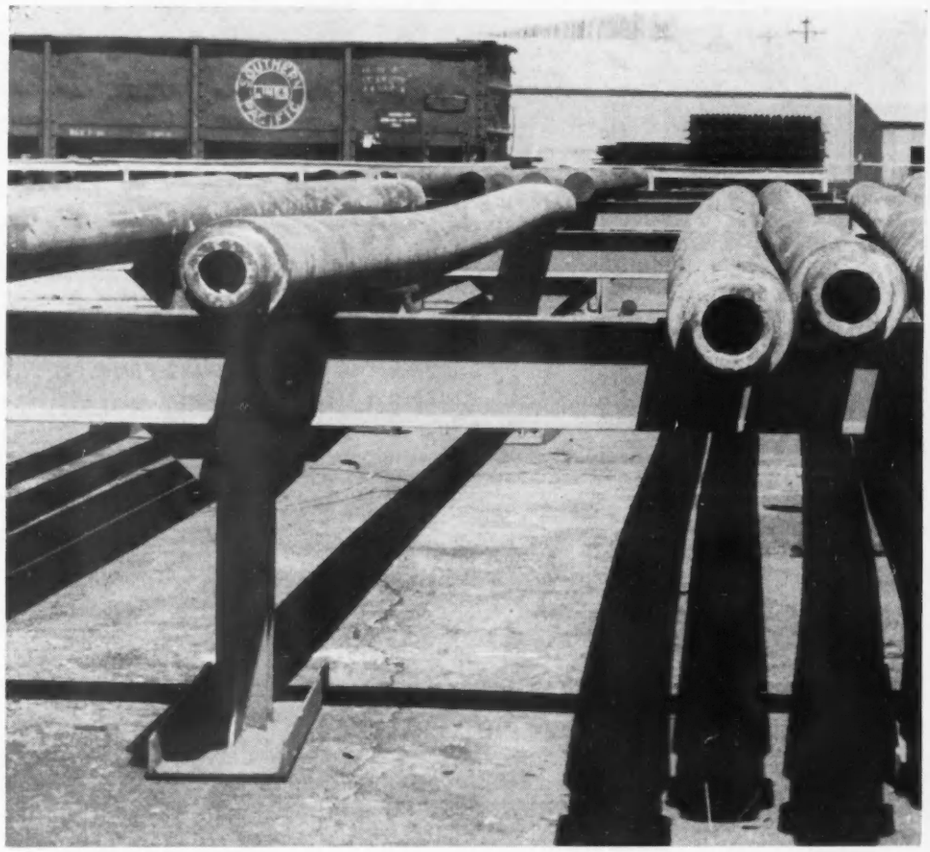


FIGURE 41—Check drill pipe and drill collars for straightness. Straighten if necessary.

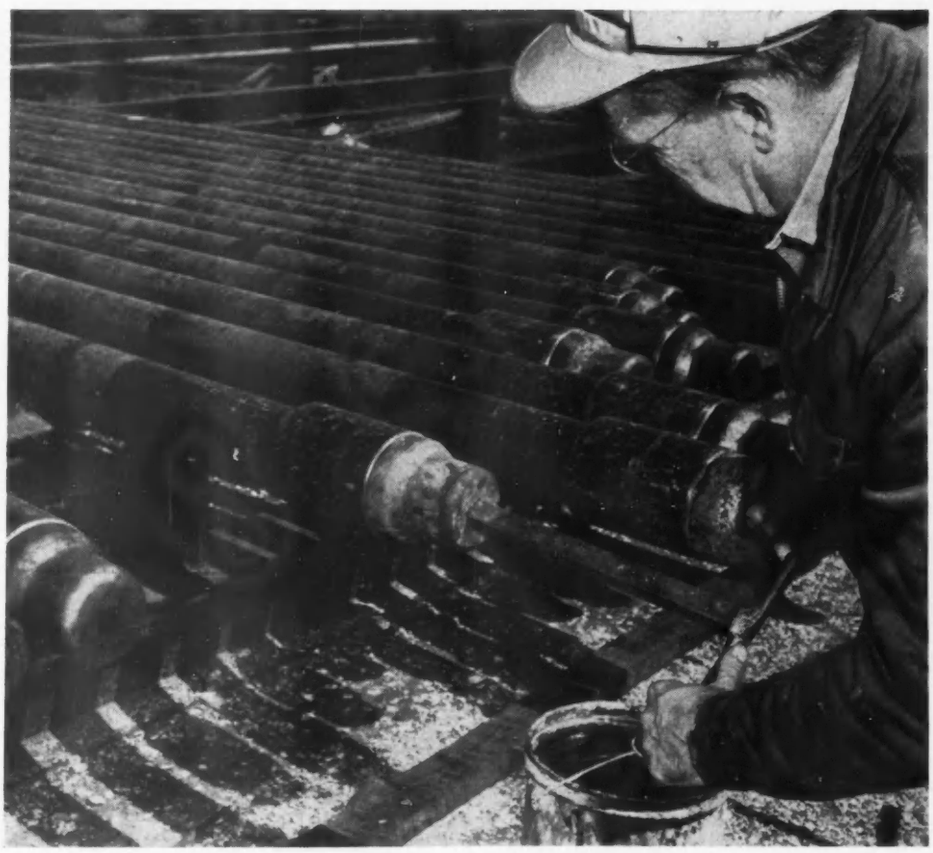
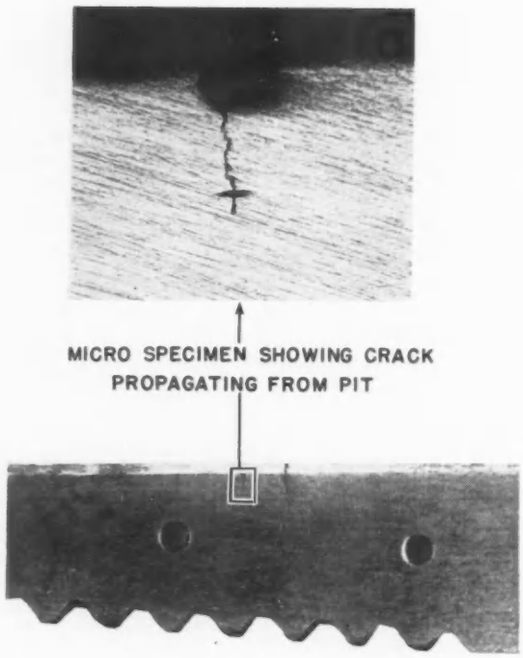


FIGURE 42—Tighten thread protectors before moving and hauling.

FIGURE 43—Corrosion fatigue crack starting in bore of pin accelerated by stress concentration from excess make-up torque.



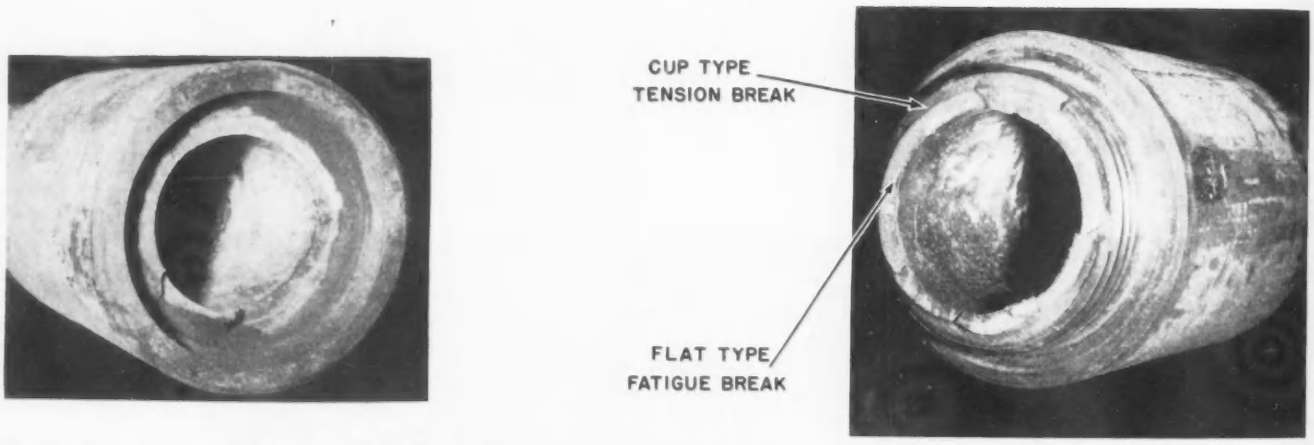


FIGURE 44—Corrosion fatigue failure resulting from crack starting in bore of pin accelerated by stress concentration from excess make-up torque, resulting in ultimate tension failure.

3. There is no true endurance limit for a drill string run in a corrosive statement.

4. When hydrogen sulfide is present, fatigue failures may develop in a very short time, even though visible pitting is not present.

Control measures

1. If salt is encountered, go to a saturated salt drilling fluid, which is much less corrosive than a non-saturated fluid.

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2. Use a suitable corrosion inhibitor in the mud. This can eliminate or minimize the problem.

3. Keep the mud in good condition . . . maintaining the correct pH arrests or retards many corrosive actions.

4. When a highly corrosive fluid is encountered, case it off where economical to do so.

5. Maintain the drill pipe in tension at all times . . . this will minimize the possibility of a fatigue failure.

6. When one or two drill string failures resulting from corrosion occur, consider retiring the string before failures become epidemic.

7. Inspect entire drill string more frequently.

8. Internal coating or peening of the drill string can often reduce the effects of the corrosive fluid.

TO BE CONTINUED

Lisbon anticline: hottest area in the Paradox Basin

Major Devonian and Mississippian discoveries increase interest in other major anticine trends

A NEW ERA is underway in Paradox Basin activity. The targets: Mississippian and Devonian production in the Lisbon anticline area of Utah and Colorado.

In October, 15 wells, active drilling operations and locations were listed for the Lisbon area. Three dry holes increased total drilling to 18 wells.

The discovery that sparked the new exploratory effort was spudded in by Pure Oil Company in August 1959 on the northwest end of the Lisbon anticline in Utah's San Jaun County. Three months and nine days later, Pure was running logs after reaching total depth of 8,440 feet. Production had been found in both Missisippian and Devonian formations.

The wildcat, Northwest Lisbon 1, is about 30 miles south and east of Moab, far removed from recently developed centers of oil activity in southeastern Utah, and geologically unique because of Devonian oil production.

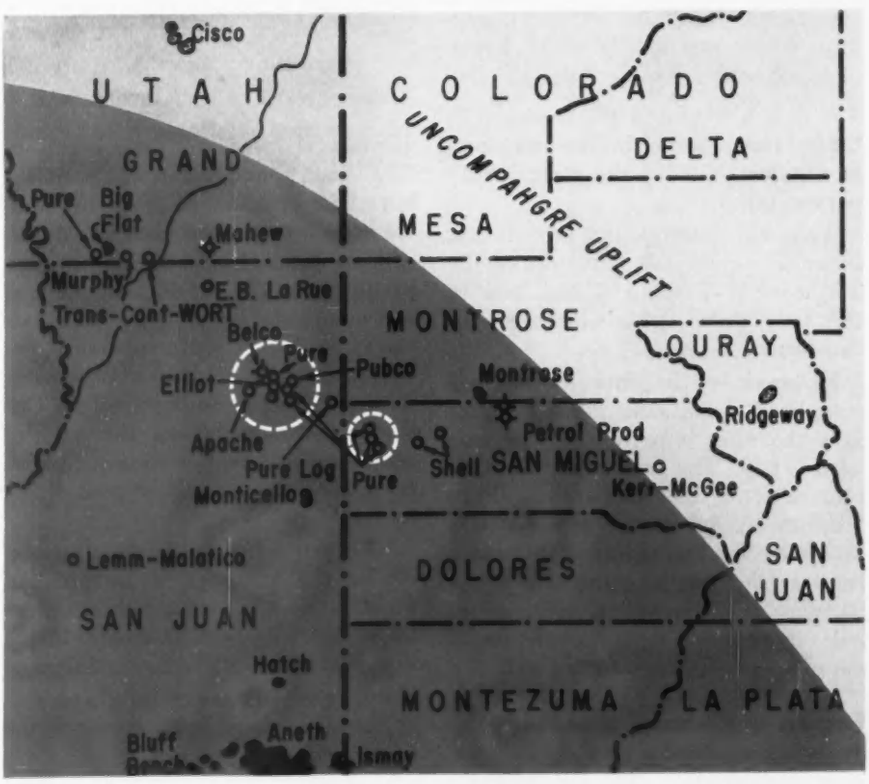
Nationwide attention. Pure's first announcement of gas flows ranging from 1.2 to 17 MMcf per day (with some condensate) through 450 feet of Mississippian section, received nationwide attention. Only Big Flat, to the northwest, was previously known for commercial production from Mississipian.

Shortly after the first of this year, Pure reported an official gage of 587 barrels of 44 gravity oil flowing through 14/64-inch choke from nearly 70 feet of perforations in the McCracken sandstone member of Devonian under flowing tubing pressure of 250 psi. Devonian shows previously had been logged at a few widely separated spots in Utah, but had never before produced in the state.

This gage quieted the misgivings that were the natural reaction among observers during the extended period of testing. During this time it had become known that the high volumes of gas from the thick Misisippian section included some inert gases, and that the average btu content was about 750 per cubic foot. This brought to mind the gas-condensate recoveries logged some years before in the Monticello area of the county and later proved non-commercial.

The first reports of Devonian shows were met with some reservation.

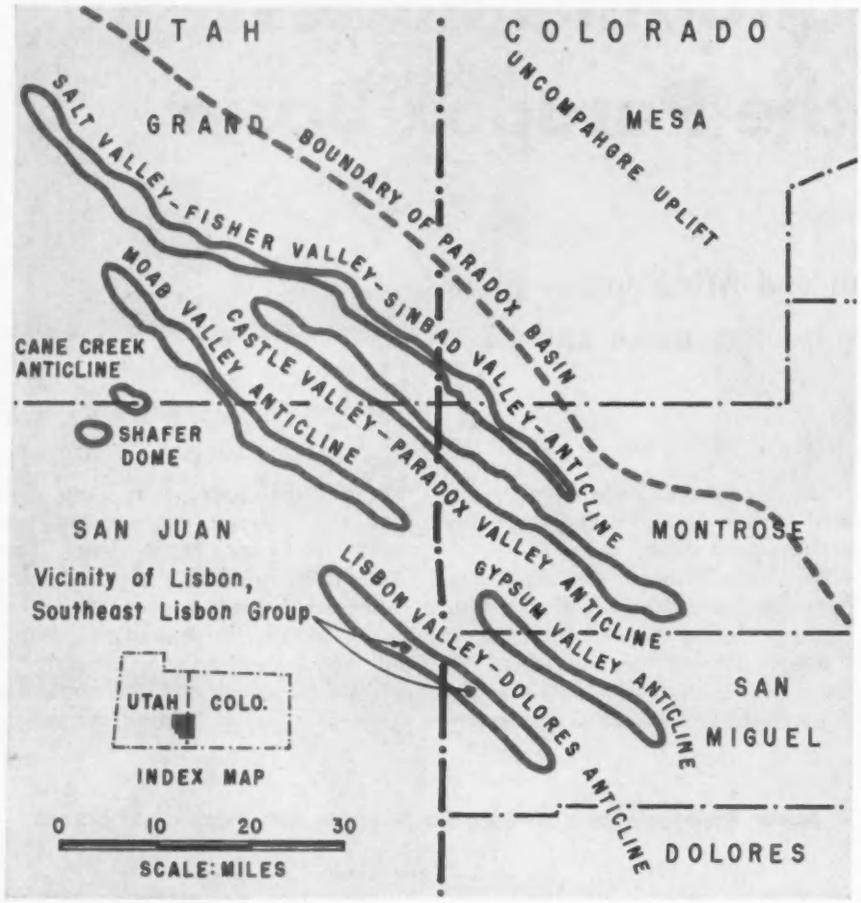
New Exploration Areas in Northeast Paradox Basin



Dark Colored Area: Paradox Basin — Oil Field — Gas Field
Dashed Circles: Lisbon, Southeast Lisbon Fields

Salt Cores of Anticlines in Paradox Basin

(Utah-Colorado)



Other, lesser, shows in this formation in various parts of the state hadn't panned out.

Too, old Utah hands noted that shows along the salt anticlines of the northeastern Paradox Basin had in the past come to a will-o-the-wisp conclusion.

However, by the time the well was completed, it had been labeled as possibly the most important of the year in the U.S. The concensus was that something big had appeared again in Utah oil exploration. Whether it was as big as the Pennsylvanian development further to the south was but a speculation. It is still a speculation, but the evidence since completion of the discovery well is mostly good.

Second well shows promise. Mississippian assumed a new significance at a well a little more than a mile west of the discovery. Elliott Production spudded Lisbon Valley-C1 in late January. It went to total depth of 9,553 feet, found shows in Devonian, but the formation swabbed dry and the well was plugged back to Mississippian. From this formation, through perforations 8,767-8,830 feet, the well was completed for a flow of 272 barrels of 53 gravity oil (condensate) per day through 16/64-inch choke under flowing tubing pressure of 660 psi. Gas flowed on this test at the rate of 686,000 cubic feet per day. Gas/oil ratio reported by Elliott was 2,520 to 1.

This put a little different complexion on the Mississippian potential of the area, with liquids assuming a more important role than indicated in the Pure Oil discovery well.

Pure's well is at the northwest end of the structure. Elliott, a mile to the west, or Basinward side of the Pure well, topped Mississippian at —2,347 feet, 1,398 feet below the —949 top in the Pure well. Top of the McCracken member of Devonian in the Elliott well is at —3,093 feet; in the Pure well, —1,680 feet, showing this formation 1,413 feet lower.

A subsequent well by Pure about two miles southeast of the discovery found McCracken at —2,153 feet. It has been shut in after flowing 841 barrels of 45 gravity oil with gas at the rate of 500,000 cubic feet per day on 36 hour test from McCracken perforation at 8,905-43 and 8,960-98 feet.

Flow was on quarter inch choke. From Mississippian this well flowed 413 barrels of condensate and gas at the rate of 6.2 MMcf per day on 35/64-inch choke on 24 hour test.

Four-mile trend. Production has been established over a northwest-southeast distance of more than four miles, and a width of three miles or more.

Pure has nine wells or locations in the Lisbon area. Belco Petroleum has three. Pubco Petroleum, two; Standard Oil of California is drilling below 4,200 feet at its one well; Western Operation, Elliott Production and Apache Drilling each have drilled one well.

Pubco Petroleum is testing a successful stepout in SW 12-30s-24e, has logged flows of as much as 45 barrels of condensate per hour. Pubco's second well in the area is still a location.

After drilling a dry hole, Belco's second well, in c NE NE 15-30s-24e has flowed as much as 500 barrels of oil per day with 1.2 MMcf gas per day from Mississippian. Belco's third well is drilling below 3,625 feet on the Egnar unit, southwest of Pure's third southeast Lisbon well.

Three dry holes. The first dry hole in the area was logged by Belco Petroleum at a wildcat three miles northwest of the Pure discovery. It found shows in both Mississippian and Devonian, but neither formation was commercial.

Pure's USA-D 1, about three miles southeast of the company's discovery was abandoned after logging shows, but details have not yet been fully released.

Apache Drilling's Federal 1, almost three miles southwest of the Elliott

". . . Spacing, crystallization of exploratory plans, rate of drilling indicated by market, results of new wildcats now staked on Lisbon anticline . . . will determine the rate of growth of this most important new producing area in the Rockies."

discovery, was dry at total depth of 9,325 feet. The most southwesterly location yet staked in the area, it topped McCracken at 9,226 feet from a derrick floor elevation of 5,958 feet. It recovered some gas cut mud on drillstem test in Mississippian, but had no other shows reported.

Salt-Core anticlines. The northeast portion of the Paradox Basin is characterized by a series of salt-core anticlines paralleling the Uncompaghre Uplift which forms the northeastern boundary of the basin. They extend into the Colorado portion of the basin and in some cases are well defined for more than 75 miles. The Lisbon Valley—Dolores anticline, on the northwest end of which the Lisbon discovery was drilled is the most basinward of the series.

At about the same time the Lisbon discovery was testing, Pure also began testing Govt-Southeast Lisbon 1, NE NW lot 3, 5-44n-19w, San Miguel County, Colorado, toward the opposite end of the structure and nearly 17 miles from the Utah discovery. It found gas in Mississippian, has been shut in after flowing upward of a million cubic feet per day from this formation, with some condensate. Total depth at this well is 9,972 feet.

This discovery shared in the attention generated by the Utah discovery, but the gage was eclipsed by the more substantial Devonian success at Lisbon, as well as better Mississippian performance. A second well a mile to the south was more notable, flowing 6 MMcf per day from Ouray (Devonian) and 6.5 MMcf per day with 136 barrels of condensate from Mississippian, thus establishing the same two producing formations as at Lisbon. A third well was even more convincing. It is two and a half miles south of the discovery, has been shut in after flowing gas at the rate of 6.4 MMcf per day with 70 barrels of condensate in 15 minutes from Devonian perforations at 9,054-62 feet.

A fourth location has been staked to the north of this discovery.

Activity gains momentum. The Lisbon-Southeast Lisbon development is just gaining momentum. It has had its influence on the entire salt anticline area of the basin. Several major deals on leases in the area followed the Lisbon discovery immediately, with bonuses to leaseholders of up to $100 per acre, plus substantial overrides reported. One such transaction involved Shell Oil's acquisition of 88,000 acres in Utah and Colorado at $24 per acre. A 5 percent override was retained by Penrose and Tatum, Fort Worth, who turned the block to Shell. Acreage is partially in Montrose County, Colorado, northeast of Montrose Dome. In Utah, a substantial block is in 28s-26e, north and east of Lisbon and in the Gypsum Valley-Paradox Valley anticline area.

The entire area is heavily leased, consists of a majority of state and federal acreage, and many major and independent operators have, or have attempted to secure, position in the area. Drilling to date except for that mentioned at Lisbon and Southeast Lisbon, has been scattered.

Farmouts seem to be close. There are heavy holdings through both the Lisbon and Southeast Lisbon areas, but apparently there will be no great amount of farmout pending further drilling.

Next year might see farmouts materialize outside the area of primary influence and success on each end of the anticline.

Obviously, the entire northeast quadrant of the Basin must be heavily explored in consequence of the Lisbon-Southeast Lisbon discoveries. Currently, one attempt at more remote activity on the same structure has been scheduled by Pure. It is 1 Island Mesa, C NW SW 22-30s-26e, between Lisbon and Southeast Lisbon, and near the Colorado line. The well, scheduled to Devonian at about 11,500 feet, was fishing at 3,694 feet in October.

The pattern of development to come at Lisbon has not yet been set. Hearings on spacing are set for December 6. Proposals for 80-acre spacing for Devonian, 640 acres for Missisippian were originally made. Intervenors have since asked both 160 and 320 acre patterns for Mississippian and 160 acres for McCracken.

Recent Rocky Mountan trend has been to the widest spacing shown consistent with good engineering practice.

A steady and growing drilling program, both development and exploratory, but not a feverish program, is a reasonable expectation for both the Colorado and Utah portions of the basin. Some of the equipment originally located in the Paradox Basin on the basis of the Pennsylvanian play is now busy with this new area of activity. Contractors active on wells already drilled or drilling include Loffland Brothers, Noble Drilling, Kent Drilling, Arapahoe Drilling, Moran Drilling, and Calvert Drilling.

There won't be a big influx of new equipment to the northeastern Paradox right away, Spacing, crystallization of exploratory plans, rate of drilling indicated by market, results of new wildcats now staked on the Lisbon anticline are some of the questions whose answers will determine the rate of growth of this most important new producing area in the Rockies.

Current big question . . . which of the other major anticlinal trends will next be proved productive?

—The End

Offshore Louisiana . . .

How new underwater oil storage unit works

Unique 20,000-barrel capacity submersible battery completely equipped with all producing facilities, can be moved easily from one field to another without use of heavy marine equipment

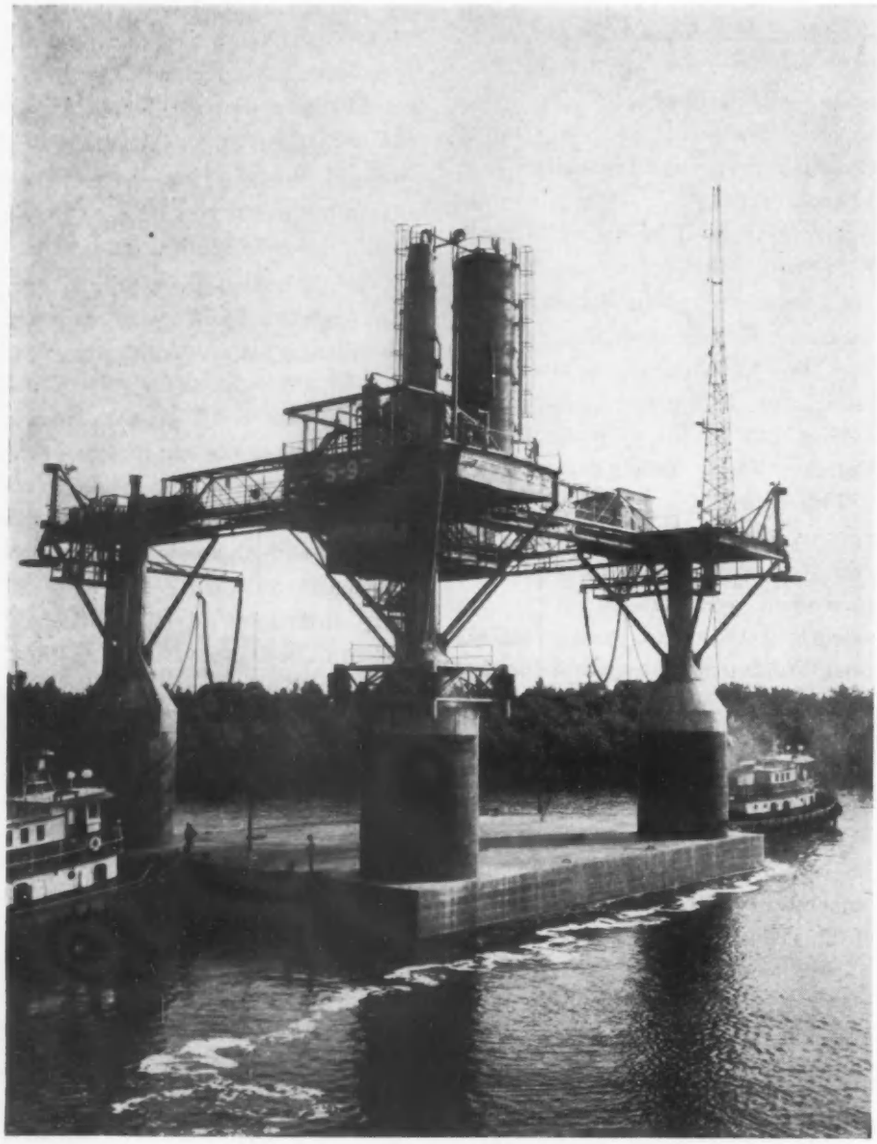


FIGURE 1—New 20,000-barrel capacity mobile underwater oil storage unit is shown under tow to Calco's Eugene Island Block 110 field in Gulf of Mexico. Pump platform is at left, production platform in center foreground, compressor platform at right and quarters platform is in center background.

By Ray Lacy
Assistant Manager of Sales
John Estes, Chief Engineer
Bethlehem Steel Company
Ship Building Division,
Beaumont, Texas

A NEW 20,000-BARREL CAPACITY underwater oil storage unit complete with all producing facilities has been installed in Eugene Island Block 110 field off the Louisiana coast for The California Company. The self-contained submersible unit was sunk in 35 feet of water adjacent to a well platform. The only connection work required for operation involved tying well flow lines into the production manifold on the unit. Chief advantages of this type battery are as follows:

- The unit has mobility comparable to mobile offshore drilling rigs and may be moved easily from location to location.
- Marine construction equipment is not required for installation.
- It is designed to withstand severe weather conditions and is as permanent on location as any other offshore structure.
- The steel storage tanks, as designed and fitted with cathodic protection, are safe from rupture, abrasion and adverse effects of marine growths and organisms.
- The filling and discharge operation requires no special training of

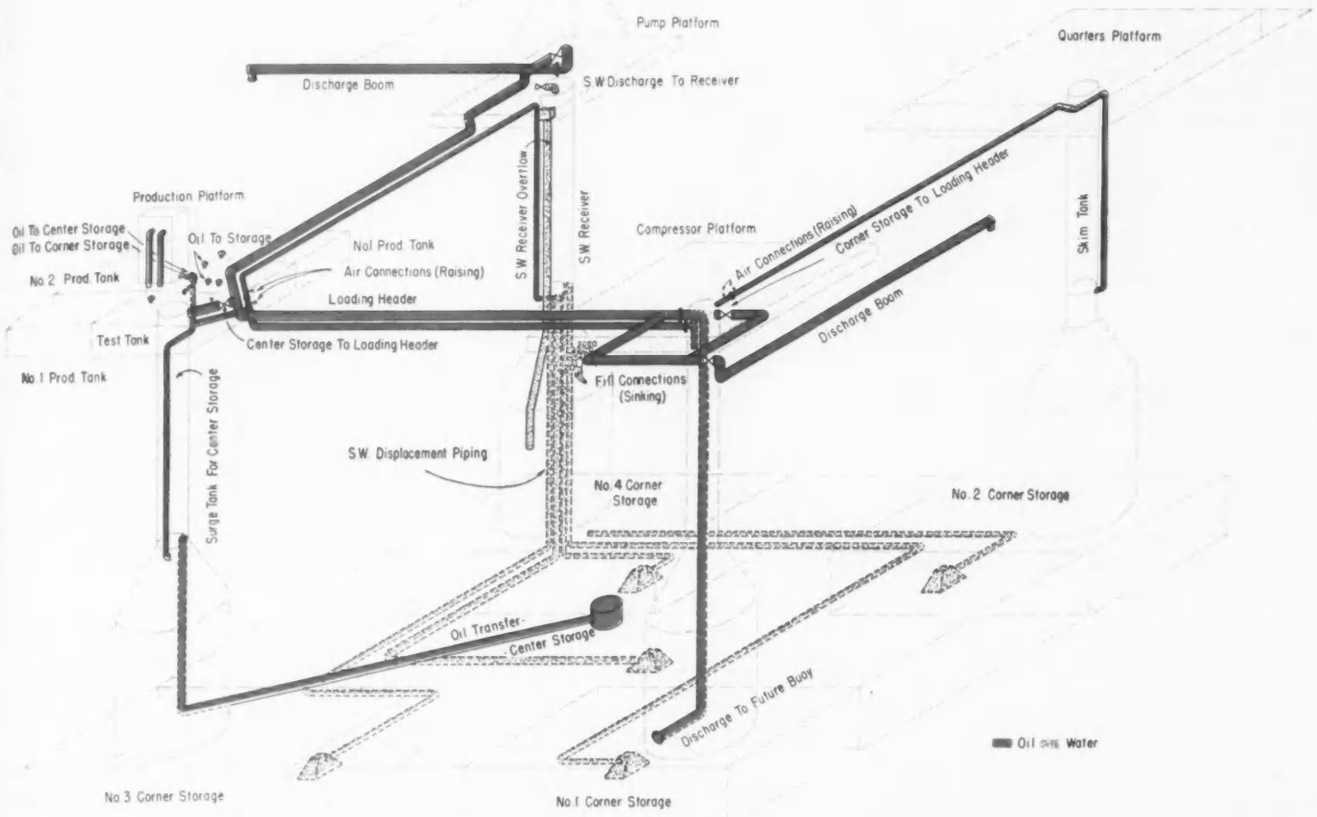


FIGURE 2—Here is an oblique drawing of the oil transfer and salt water displacement piping system. The blanked connection on the column above No. 1 corner storage was provided to accommodate a future oil line. If installed, this line could be connected to floating loading facilities located some distance from the structure. Thus, marine equipment or tankers will be able to load safely at sea without danger of damaging the unit.

field personnel, nor are mechanical devices required to prevent salt water contamination of oil, or spillage of oil through the sea water displacement system.

- Basic sediment, sand and other solids can be removed without raising the unit from its submerged position.
- Preventative maintenance is performed easily from above water.

The same basic design and principles employed in the 20,000-barrel unit can be used to construct a unit capable of storing one million barrels or more in water depths in excess of 200 feet, with or without production facilities. Thus, it is felt that units of this type, which resulted from years of research, design and development, will provide the answer to problems posed by oil fields located beyond the economic reach of pipe lines, or in deep and exposed waters where conventional production and storage facilities are not feasible. Figure 1 shows the unit under tow.

The battery is towed to location in the same manner as mobile offshore drilling rigs. By use of tugs and anchors, the unit is positioned and flooded until it comes to rest on the ocean floor. After setting on location, flow lines from the wells are connected to the input manifold and the battery is ready for operation as a production facility. Conversely, to remove the unit, flow lines are disconnected and tanks are deballasted. When afloat, the unit is ready for towing to its new destination.

This unit provides a net oil storage capacity of 20,000 barrels and has a maximum sinking depth of 35 feet. It will handle a production input rate of 2,000 bopd and discharge to marine transportation equipment at a rate in excess of 2,000 boph. General configuration of the unit is a large rectangular mat, 112 feet x 92 feet x 10-feet with four 18-foot diameter corner columns extending 25 feet above the mat deck. At that point, columns are tapered to a diameter of 5 feet. Each column supports a platform above maximum wave height. Quarters, heliport, production equipment, generators and pumps are installed on these platforms which are interconnected with walkways.

Primary storage is within the mat and columns. This volume is divided into two oil compartments which permit simultaneous production and delivery of oil. Salt water rolling lines are installed on the tank bottoms to provide agitation for removal of sediments. Permanent type anodes are installed within the compartments to provide permanent cathodic protection.

Production platform. The 30 foot x 30 foot x 4-foot production platform is built as a rectangular tank. The tank

top provides deck area for producing equipment. Foundations also were provided for anticipated equipment as well as that installed prior to delivery.

The tank is subdivided to provide 130-barrels test tank capacity, and 630-barrels settling tank capacity. Four bolted cleanout doors are provided for tank cleaning.

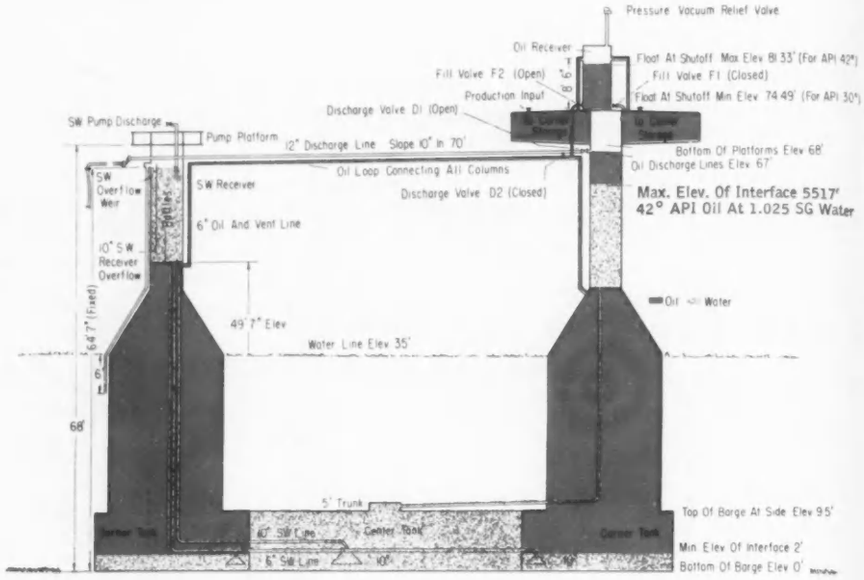
Equipment installed on the platform deck includes:

- Input production manifold.
- 3 foot x 10 foot, 125-psi W.P. test separator.
- One 3½ foot x 10 foot, 125-psi W.P. and one 4 foot x 10 foot, 125-psi W.P. production separator.
- Three meter runs for gas production.
- 4 foot x 27½-foot, steam heated, emulsion treater for test use.
- 10 foot x 27½-foot steam heated, production emulsion treater.
- 5,000-pound capacity stiffleg boom.

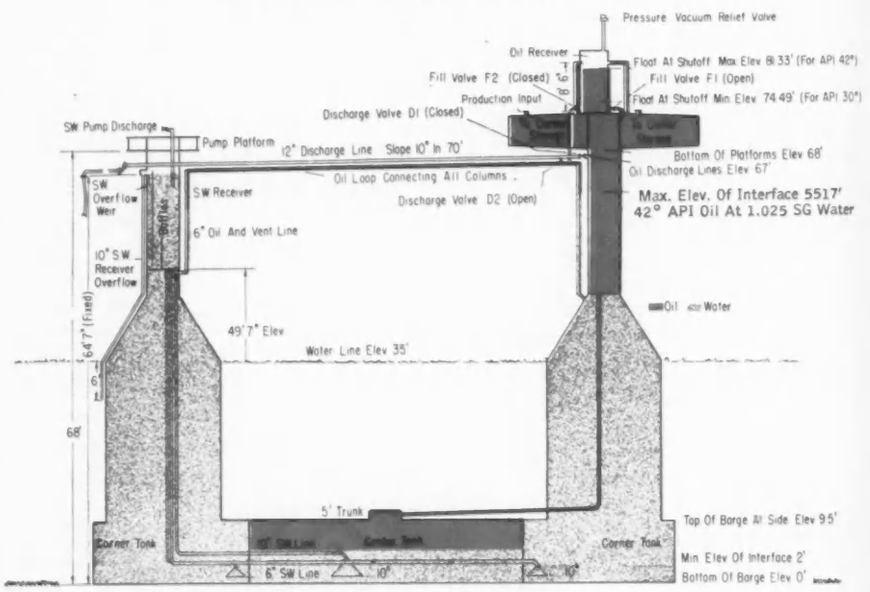
An oil receiver, which functions as a surge tank and distribution reservoir, is located in the center of the platform. Two fill lines lead from the receiver to the two underwater storage compartments (See Figure 2).

Compressor platform. This 30 foot x 30-foot beam and girder steel decked structure is fitted with a 100-foot radio tower, two 30 KW 120 - 208-volt A.C. generators housed in a sheet metal building, foundations for future installation of a gas compressor for gas lift operations and a 12 foot diameter x 17½-foot salt water precipitator. A 50-foot oil discharge hose boom is installed on the outboard corner.

Pump platform. The 25 foot x 18-foot pump platform is constructed similarly to the compressor platform and contains two engine driven deep well salt water pumps of 2,100 gpm and 600 gpm capacity. These pumps provide salt water for the oil discharge phase of the operation, salt water supply for the rolling lines and serve as fire pumps. A 175-gpm washdown pump and a 4 foot x 15-foot steam generator which provides steam for the emulsion treaters also are installed on this platform. An additional oil discharge hose boom is located on the outboard corner of the platform.



A Corner Compartments Full
Center Compartment Empty



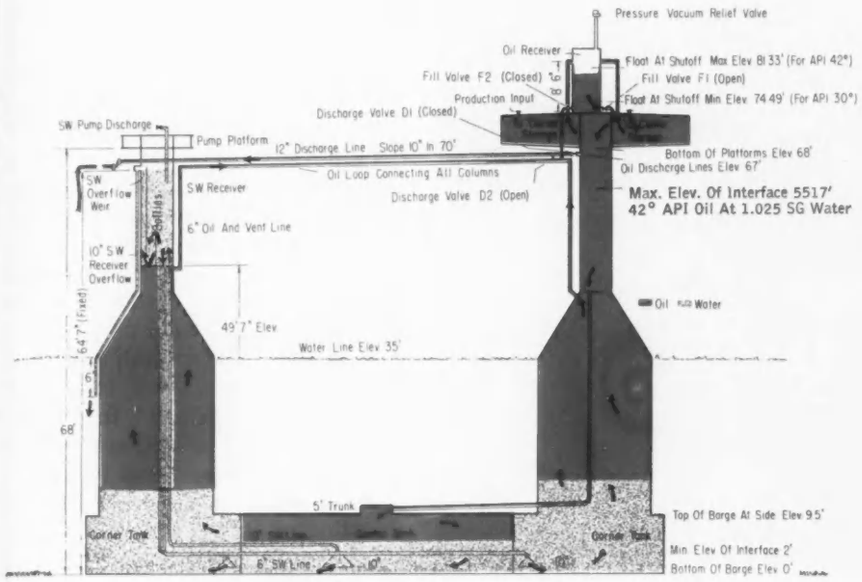
C Corner Compartments Empty
Center Compartment Full

FIGURE 3—These four schematic drawings show various conditions which are indicated on the individual drawings.

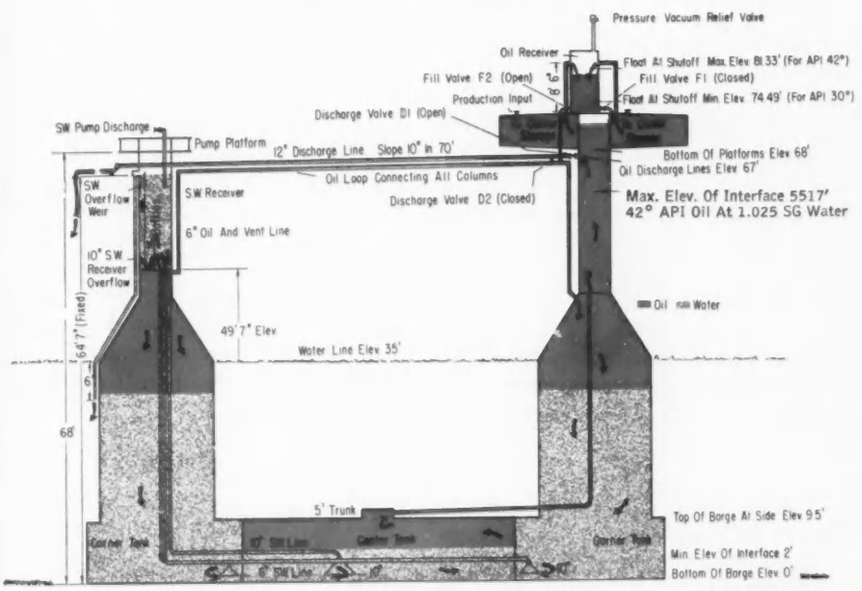
Quarters platform. This structure consists of a 30 foot x 30 foot x 4-foot rectangular tank structure with an 8-foot cantilevered deck extension, giving a total deck size of 38 feet x 38 feet. The tank provides 300-barrels potable water and 500-barrels sanitary water storage. A 32 foot x 25-foot building provides space for a 8 foot x 25-foot warehouse in which shelving, paint locker, deep freeze, radio equipment and two water pressure sets are installed. The rest of the building is used for quarters which provide eight-man berthing, office, a complete galley and recreation and dining area. The quarters area is equipped with a vented gas heating system and air conditioning.

A 4,000-pound stiffleg derrick for hoisting supplies aboard is installed on the outboard corner and a 60 foot x 60-foot helicopter landing deck is installed above the quarters.

Columns supporting the production and quarters platforms are provided



B Corner Compartments Discharging
Center Compartment Filling



D Corner Compartments Filling
Center Compartment Discharging

exist when the unit is in operation. Specific operations (two static, two fluid)

with 18 foot x 18-foot L-shaped boat landings located 6 feet above design water level. Spiral ladders provide access between boat landings and platforms. Mooring pads are installed on the diagonally opposite columns supporting the compressor and pump platforms. Hawsers may be attached to the pads to moor transportation equipment when discharging oil through the unloading booms located just below platform level on the columns. This permits marine equipment to approach the unit regardless of wind direction.

Corrosion control of the exterior of the unit consists of three separate systems. An impressed current carbon anode cathodic protection system has been installed to protect submerged surfaces. Monel sheathing of the steel columns provides protection against air and salt water corrosion in the spray zone. Above the monel, exposed surfaces are either hot dipped galvanized or coated with a 3 mil zinc silicate system and two coats of vinyl mastic.

Production operations. Well fluids are produced through the flow line manifold into separation equipment, treaters, metering devices and settling tank. The settling tank serves two functions: First, the weight of fluid contained in the tank increases the soil bearing load of the entire structure. Also, the tank provides a retention chamber for the produced oil. This permits solids to drop out of the oil in an easily cleaned tank, rather than being introduced into the submerged storage section.

After a retention time of approximately seven hours, based on the volume of the tank and the production rate, the stabilized oil flows into the oil receiver where it is diverted to the selected storage tank.

As the oil flows by gravity into the selected submerged storage tank, sea water in the tank is displaced through the sea water piping system. When oil level is within 24 inches of the bottom of the tank (see Figure 3c), the weight of the water column and the oil column is equalized and no further displacement of water is possible. This precludes the possibility of flowing oil out through the sea water system. Simultaneously, the level of oil in the receiver has risen to a point to actuate a liquid level control which will shut-in production. An alarm system, which is tied into the control unit, will produce an audible and visual signal several hours prior to the "full" condition.

To discharge oil from the submerged tanks, the fill valve on the oil receiver to the full tank is closed and the applicable oil discharge valve is opened. Sea water is discharged from the deep well pumps under no pressure into the water receiver and, since the oil column has been shortened by opening the discharge valve, flow is possible in the opposite direction. Figure 2 shows the oil transfer and salt water displacement piping system.

The oil discharge line is located below the oil fill line but above the sea water discharge level. This permits introduction of sea water with corresponding discharge of oil until the sea water level in the oil storage compartment approaches the level of the sea water discharge. At that time,

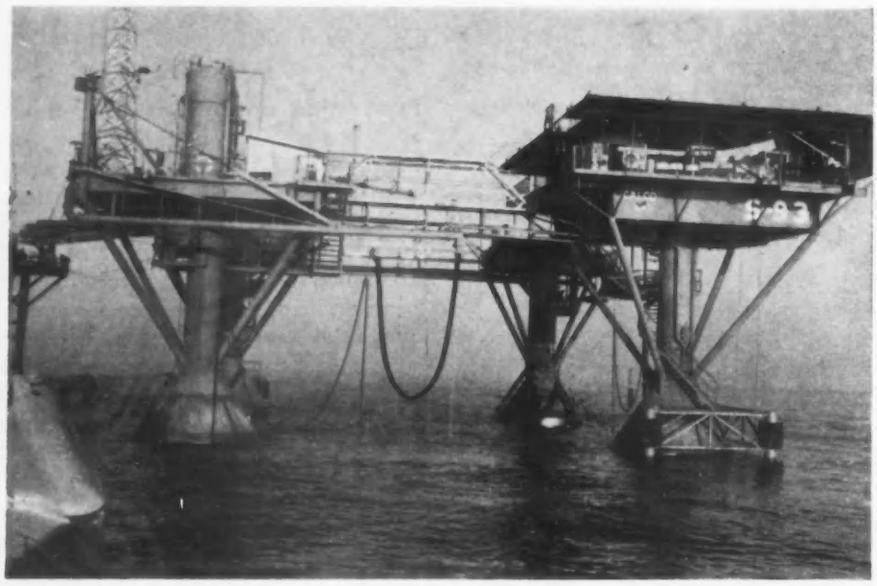


FIGURE 4—Calco's underwater oil storage unit on location in Gulf of Mexico. Well platform is at left.

equilibrium occurs and no further flow through the oil piping can occur. This precludes the possibility of sea water being carried over in the oil being discharged for sale. Figure 3 shows the complete fill and discharge sequence.

Although the weight of the unit is adequate to prevent flotation when the submerged tanks are filled with oil, the fluid contained in the production platform tank and the quarters platform tank is more than enough to offset the buoyancy due to the submerged oil. This provides weight plus additional storage capacity at no greater cost than applying weighted ballast on the mat hull and results in adequate soil bearing for storm conditions.

Extensive testing of Gulf Coast crude oils in this system indicate that a properly designed unit will encounter no emulsion problems. The tests also indicated that oil delivered from the unit will contain only those contaminants present in the original well-stream. In some cases, impurities were removed from the oil as it was moved through the unit. Provisions have been made to permit withdrawal of emulsions should they be accidently introduced into the storage tanks because of treater failure, etc. Emulsified fluid then can be circulated through the steam heated treaters to recover clean oil.

Particular attention was given to the prevention of oil contamination of sea water, both in the displacement system and if accidental spillage occurs on the decks of the various platforms. Skimming devices were installed in the sea water discharge system and in the deck sumps which receive any spilled fluid. Periodic skimming of these containers precludes accidental carry over of oil into the sea.

Applications. The underwater storage unit has the greatest potential use in major producing areas where a marine pipe line to shore is impractical or uneconomical. In this instance, the unit would be considered a permanent installation and would be in place for the life of the field.

In other instances, salvability is as important as initial cost. This is applicable in areas where there are pipe lines projected, but appreciable production will be lost due to the time elapsed before lines become available. Also, a relatively small unit could be used in the early exploration stages of field development. This unit would permit production until field potential could be determined and permanent facilities designed and installed.

As described previously, no dismantling or use of expensive marine equipment is required to put the unit in a movable condition for complete recovery. The equipment also is available to many foreign areas. The ability of the marine towing industry to move units of comparable size and shape over transoceanic distances has been demonstrated many times.

The underwater storage unit (patent pending) offers adequate production facilities suitable for deep water operations. Marine oil fields presently beyond the economic reach of pipe lines, or in deep and exposed water that makes economic use of conventional production facilities impossible, may now become profitable operations rather than undeveloped reserves. —**The End**

About the Authors

Lacey

Estes

Ray Lacey was educated at The University of Texas and the University of Arizona, and has had wide experience in ship building. Prior to joining Bethlehem Steel Company in 1947, he was employed as an engineer by Sun Oil Company in Beaumont and Longhorn Tin Smelter in Texas City. He is a registered professional engineer in Texas and is a co-patentor of the underwater storage unit. He presently is assistant manager of sales for Bethlehem's Ship Building Division in Beaumont.

John Estes was graduated from The University of Texas in 1946 with a B.S. degree in mechanical engineering. After three years with other marine fabricators, he was employed at Bethlehem's Beaumont Yard in 1949. He served in various engineering positions with Bethlehem until January 1960 when he was appointed chief engineer of the Beaumont Yard. He is a registered engineer in the State of Texas in both mechanical and structural engineering, and is a member of the American Society of Mechanical Engineers and the Society of Naval Architects and Marine Engineers.

Deep gas search sparks South Texas exploration

Deep Edwards and lower Wilcox plays active from Lavaca County to the Mexican border

By Roy I. Jindra, Geologist
Harkins and Company, Alice, Texas

EXPLORATION PROGRAMS have been revised in all major south Texas trends, with primary current emphasis on gas-condensate production instead of on oil. Deeper drilling is and will continue to be the most active form of exploration. Although fewer wildcats will be drilled as they go progressively deeper, a higher discovery rate probably will result from the more careful, selective preparation of deep prospects to be drilled.

The Edwards trend from Webb County northeastward through Lavaca County should see numerous wildcats drilled in the near future. The Wilcox trend is especially active along the downdip fringe. The lower Wilcox sands are enjoying an intensive play. This trend is active from Zapata and Starr counties through Lavaca County.

The Frio-Vicksburg trend has been relatively inactive, although Hidalgo, Kleberg and Calhoun counties have enjoyed some important recent exploratory successes.

Recent months have seen a rapid shift from an almost stereotyped exploratory approach, i.e., drilling along currently productive trends at established depths, to the new frontiers of deeper drilling. The greater costs and risks tend to eliminate smaller operators and to place the exploration burden on the major companies. The ability to assemble enough acreage to justify deep tests in areas where much acreage is held by shallow production is also becoming a crucial factor.

Exploration in Railroad Commission Districts 1, 2 and 4 is being slowed by extremely tight oil production proration and state taxes. Outlets for gas are also handicapped by price regulation at the federal level. However, fairly strong intrastate gas markets are mitigating the marketing problem for gas somewhat, and drilling for new, deep gas reserves is hence being stimulated.

Various producing trends are discussed by Railroad Commission districts, with the more active counties being covered in detail.

RAILROAD COMMISSION DISTRICT 1

The area covered by this district consists of 33 counties from Mason County southeast through McMullen County and from Valverde County northeast through Bell County. Geologically, production is found in the area from Ellenburger lime upward through the section into the Oakville sands (Miocene).

The most active areas in recent months have been on trend with upper Cretaceous Navarro and Taylor sands in Dimmit and Maverick counties. Three fields recently discovered in these counties have assumed considerable economic importance. The most prolific of these discoveries, Sacatosa field in Maverick County produces from the San Miguel zone of the Taylor and is stimulating activity along this trend. The Hugh Fitzsimmons field, producing from various zones in the Taylor, Navarro, and Austin chalk, and the Celeste-Fay field which produces from several zones in the Navarro, are very important also. A new shallow exploratory trend is evident here.

Major exploratory emphasis is expected along the deep Edwards lime trend from the Pescadito dome in Webb County to Bastrop County. It is anticipated that LaSalle County, north of present Stuart City production, southeastern Frio County and central Atascosa County will enjoy considerable deep Edwards wildcat-

Key to pertinent wells and fields on map

1. Fitzsimmons Field
2. Sacatosa Field
3. Celeste-Fay Field
4. Person Field
5. Shell Hartman 1
6. Hunt Stoelje 1
7. Mobil Kahanek 1
8. Shell Borchers 1
9. Shell Carroll 1
10. Humble Matthews 1
11. Lone Star Koenig 1
12. Cook Field
13. Harkins & Co. Machost 1
14. Commonwealth & Harkins Wuensch 1
15. Monsanto Belitz 1
16. Harkins Duderstadt 2
17. Texas Eastern Garbe 1
18. Normanna Field
19. Pawnee (Edwards Test)
20. Clayton Field
21. Harris Field
22. San Miguel (Edwards) Field
23. El Paso Farmers Life 1-B
24. Atlantic Bruni Estate 1
25. NE Thompsonville Field
26. Taqualchie Creek Field
27. Pescadito Field
28. Amerada Haynes 1
29. Jennings Field
30. Escobas Field
31. Charco Redondo Field
32. Lopena Field
33. Austral Sanchez 1
34. Harrel Flora Johnson 1
35. May Field
36. Yeary Field
37. North Alazan Field
38. Maude Traylor Field
39. North Maude Traylor Field
40. Appling Field
41. Lolita Field
42. North La Ward Field
43. Mauritz Field

Frio-Vicksburg, Wilcox, Edwards, Olmos-San Miguel trends broaden southwestward into Rio Grande Embayment.

ting along trend with recent Edwards activity in Karnes County.

The San Miguel Creek area of northern McMullen County should gain a development program to further define the productive limits of the Edwards gas reservoir discovered by Humble Oil & Refining Company Lewis Gubbels 1, drilled in 1953. Edwards development has been static in this area, although several wells have been drilled to tap Wilcox oil producing zones.

Gonzales County has had several deep Edwards tests drilled with little commercial success. Promising shows of gas in the Hunt Stoelje 1 have stimulated sufficient interest in the area to warrant a prediction that an important Edwards field will be discovered near the southeast corner of this county.

RAILROAD COMMISSION DISTRICT 2

This district is composed of 10 counties with production ranging from Edwards lime to the Oakville. These counties are now extremely active.

Lavaca County has been a good area for upper Wilcox and shallow Frio exploration. Recently, the emphasis has shifted to deeper drilling with deep Wilcox sands and Edwards lime being objectives.

Wilcox production along trend with the Brushy Creek structure had been confined to the upper Wilcox until late 1959 when Shell Oil Co. completed their William Borchers 1 from zones at 9,500 and 10,000 feet. These zones are deep in the Wilcox section and have created considerable interest in lower Wilcox. The success of this discovery (North Borchers field) should create a series of exploratory tests along the south border of the county, with deep Wilcox production

probable in the Speaks, Provident City and Vienna areas.

Probably the most exciting of recent deep wildcats is the Mobil Oil Company Kahanek 1 which was drilled and completed as the deepest Edwards gas well in South Texas and the first Edwards production in the county. This well encountered reef-type limestone and flowed gas and condensate from perforations 13,320-14,278.

Jackson County has probably been the most active area in South Texas in recent months. Exploration is widespread throughout the county ranging from Miocene sands in the Collier area through lower Frio zones in the Lolita and South Lolita field areas. Deeper drilling and development of new producing zones in various fields, notably La Ward, Gabrysch, and Lolita lead the trend toward deeper drilling on proven structures.

Probably the most interesting operation in south Texas was the completion of Sunray Graves 6 in North La Ward field as the world's first sextuple completion (WORLD OIL, July 1960, Page 79). This well is a prime example of the trend toward cutting costs. Operators will watch the functioning of this unusual well with great interest.

Several deep wells will probably be drilled to uncover a multiple-pay field in the south Lolita area.

Calhoun County drilling activity has been concentrated in the Maude Traylor-Olivia-Appling area. The San Antonio Bay field near Seadrift should see considerable activity, with the complex fault pattern in the area providing excellent wildcat prospects. Recent completion of Brazos Oil & Gas John Welder 1, located about five miles southeast of Seadrift should bring additional drilling along this deeper fault block. It is anticipated that a new field will be discovered approximately five miles northeast of the Brazos Welder 1, opening the trend for more exploration.

Victoria County activity is expected to be slack in the near future. A deep test is expected to be drilled along the Mission Valley-Thomaston-South Gohlke trend. This area is considered a prime target for deep Wilcox (12,000-15,000 feet).

Exploration will continue along the Placedo-Keeran trend.

DeWitt County has been one of the most active Wilcox exploration areas for the past several years. Drilling and exploration is expected to continue along the established upper Wilcox trend.

More recently leasing activity has boomed with most of the county being the target for deep Wilcox and Edwards plays. Leases with 9,000-foot dry holes on them are as attractive in some cases as are unexplored areas.

Deep gas-condensate find. The central part of the county from northeast to southwest has gained numerous deep wells, Shell Carroll 1 in the Brushy Creek area being the most interesting. This test was drilled to a depth of 19,765 feet before being completed through perforations from 11,187 to 11,203 feet. The well potentialed 13,000 Mcf daily with a shut in bottom-hole pressure of 8,780 psi. It was producing 5,000 Mcf per day in September 1960 with more than 60 barrels of condensate per MMcf.

Several wells are expected to be drilled near this discovery. Development of the area should uncover important gas reserves.

Farther west, Lone Star Gas Producing Co. has drilled three deep tests located about three miles southeast of Cuero. These wells had significant gas-condensate shows from 9,700 to 14,400 feet and have found two commercial zones situated 3,000 feet deeper than any other Wilcox production in the vicinity.

Somewhat up dip, Argo Oil Corp. Cook 1 found anther new deep Wilcox field at 9,800 feet. Northeast of this production, Harkins and Co. drilled two wildcat failures which may have set up still another producing area. Additional drilling between the Argo Cook 1 and Lone Star Producing Co. production to the south may likely give rise to a new gas-condensate producing area of some magnitude.

The South Yorktown area has seen significant commercial production in at least four separate fields in heretofore unexplored deep Wilcox.

The Monsanto Belitz 1 resulted in a new discovery for the deep Wilcox trend in the Yorktown area. Two additional wells have been drilled confirming this production, establishing a gas reserve in excess of 50 billion cubic feet. The area was not fully developed as of September 1960.

The old South Yorktown field had two deep tests drilled by Harkins and Company. Duderstadt 1 blew out at 10,435 feet and resulted in a lost hole. Duderstadt 2 was completed from a sand at 9,650 feet and established deep Wilcox production in this area. The deeper structure is to be further developed. Major reserves are anticipated.

The Yorktown field also was a target for deeper drilling. Harkins and Company Machost 1 discovered gas-condensate from the 9,900-foot zone.

Commonwealth Oil Company and Harkins and Company drilled Wuensch 1 in the same field and found production in the 10,400-foot sand. Gas reserves in these lower Wilcox zones should approach 100 billion cubic feet.

Monsanto, Humble, Texas Eastern Transmission Company and Shell are expected to be active along this deeper trend, drilling several future tests in the 15,000-17,000-foot range to explore Edwards possibilities.

Goliad County has been relatively inactive in recent months, with most exploration being in the updip Frio and Catahoula trend of dry gas sands. Deep Wilcox exploration should pick up in this county with excellent opportunities for production. Areas of proven upper Wilcox production afford the best targets for the lower Wilcox zones.

Bee County was a forerunner of downdip Wilcox production, with Normanna field being the largest reserve uncovered. This trend should continue to be active.

The northern portion of the county will see exploration for the lower Wilcox series and also for Edwards lime. Shell Oil Company announced plans for a 17,000-foot test in the Pawnee area. Seismic work has delineated several deep structures along this trend.

Live Oak County has been active along the downdip Wilcox trend, particularly in the Mikeska area. There has been very little activity in the lower Wilcox. This type of exploration should be most successful in the Clayton, Kittie West, Sunset, and Harris field areas.

Continued exploration is expected along the Yegua-Hockley trend in the southeastern portion of the county.

Refugio County has been relatively inactive with the exception of the Powers field area. There, Humble has developed a shallow Frio gas reserve north of the town of Refugio.

RAILROAD COMMISSION DISTRICT 4

In Duval County, El Paso Natural Gas Company has created a stir of activity in the east central part of the county by drilling Farmers Life Insurance-Yates Ranch wells 1 and 1-B. These tests are deep Wilcox plays which resulted in a blowout of the 1-B. The well was under control and was waiting on orders in September 1960. Additional drilling in the area should result in an important discovery. Further thought is being given to deeper drilling in the Hagist Ranch-Piedre Lumbre-Seven Sisters area which should result in additional deep reserves being found.

Webb County. The western and northern portions of the county have undergone activity in recent months along the Edwards trend. No significant production has been found. The southeast corner of the county should see several tests in the 10,000-11,000-foot range. Sizable reserves should be encountered in the downdip portion of the Wilcox.

Zapata County has been most active in the deeper drilling areas of Lopeno, Escobas, Charco Redondo and Jennings.

Wilcox sands are found in depth in the Rio Grande Embayment. Both structural and stratigraphic traps are present. Drilling by Jonnell Oil and Gas Company, Crescent Oil and Gas Company and others has resulted in several significant discoveries with attendant active interest in exploration in this area.

The shallower Queen City sands were less actively a target for exploration until recently, when Amerada Petroleum Corp. Haynes Ranch 1 uncovered multiple gas sands. With the discovery of multi-zone gas production three miles to the south in the Jennings field, a flurry of Queen City tests is expected in the immediate future in this vicinity.

Jim Hogg County. The northwest corner of the county should continue to be hot, with additional Wilcox reserves being found from 9,500 to 11,000 feet. This play is a continuation of the one in southeastern Webb County, along the rim of the Rio Grande Embayment.

Starr County. The most significant play in recent months is under way about 16 miles northwest of Rio Grande City.

Austral Oil Company Inc. has an indicated Wilcox discovery in Jennie V. Sanchez 1. The well was drilled to 13,116 feet and casing was set to 11,524 feet. The Wilcox section is unofficially reported productive in several zones, and it is expected that additional wells will establish a trend of considerable importance along the east flank of the Rio Grande Embayment.

Hidalgo County has been very active and should continue to be so. Much of the activity is in the Donna-San Juan and South McCook areas.

Harrell Drilling Co. Flora Johnson 1 is apparently an important find, with production established in four or more zones of the Frio. Large gas-condensate reserves should result from additional drilling.

Kleberg County has been one of the most active and successful areas in south Texas, with several new fields found in recent years adding appreciably to the region's reserves.

The May field has been active, with more recent development in the Yeary portion of the fault block. Four deeper producing zones have been established by drilling during the past several months.

North Alazan field is probably the most important field discovered in Kleberg County in many years. Humble had completed 22 wells on this portion of its King Ranch holdings as of August 1, 1960. Statistical results of this exploratory and development effort are shown in Table 1.

TABLE 1—Completions in North Alazan Field, Kleberg County, as of August 1, 1960 (all by Humble Oil and Refining Co.)

Wells drilled	22
Single completions	5
Dual completions	5
Triple completions	7
Quadruple completions	5
Oil completions	49
Gas completions	9
Producing zones	13
Zones tested capable of production	34
Total productive zones	47
Oil sands	17
Gas sands	30

Development of this lucrative field shows that large oil and gas reserves are still to be found in the Frio trend along the south Texas coast, despite the high density of drilling in some parts of it. —The End

About the Author

Roy I. Jindra is geologist with Harkins and Company, Alice, Texas. Jindra was born in Omaha, Neb. After receiving his B.S. degree in geology from the University of Kansas in 1948, he joined Amerada Petroleum Corp. and worked in the geological department, first in Tyler and later in San Antonio, Texas. In 1951, he joined Kirkwood and Company, the predecessor of Harkins and Company.

How to complete high-pressure gas wells

Concentric tubing strings combined with good materials, proper production practices and top supervision provide safe solution to a serious problem

By W. D. Smith, Jr.
Chief Petroleum Engineer
Union Texas Natural
Gas Company, Houston

UNION TEXAS NATURAL GAS COMPANY has found concentric tubing string installations to be the safest means for completing and producing high pressure (6,000 psi +) gas wells in South Louisiana. Current practice is to install 1¼-inch integral joint tubing inside the normally used 2⅞-inch tubing string. The 1¼-inch kill string is run open ended and hung free in the larger tubing. The procedure has been used successfully in wells with surface tubing pressures as high as 13,000 psi.

The technique provides complete well control at all times and a means for introducing corrosion inhibitor into the well bore. Also, flow rates as high as 21 MMcfd have been obtained from wells equipped with concentric installations. This article describes Union Texas Natural Gas Company's experience with the technique.

Abnormally high well pressures have been one of the most serious drilling and producing difficulties encountered in South Louisiana by Union Texas Natural Gas Company. The company's first experience with high pressure completions occurred in 1944, with the completion of Gueno 3 in Branch field, Acadia Parish, Louisiana.

On completion, the well began to flow wash water and in 40 minutes

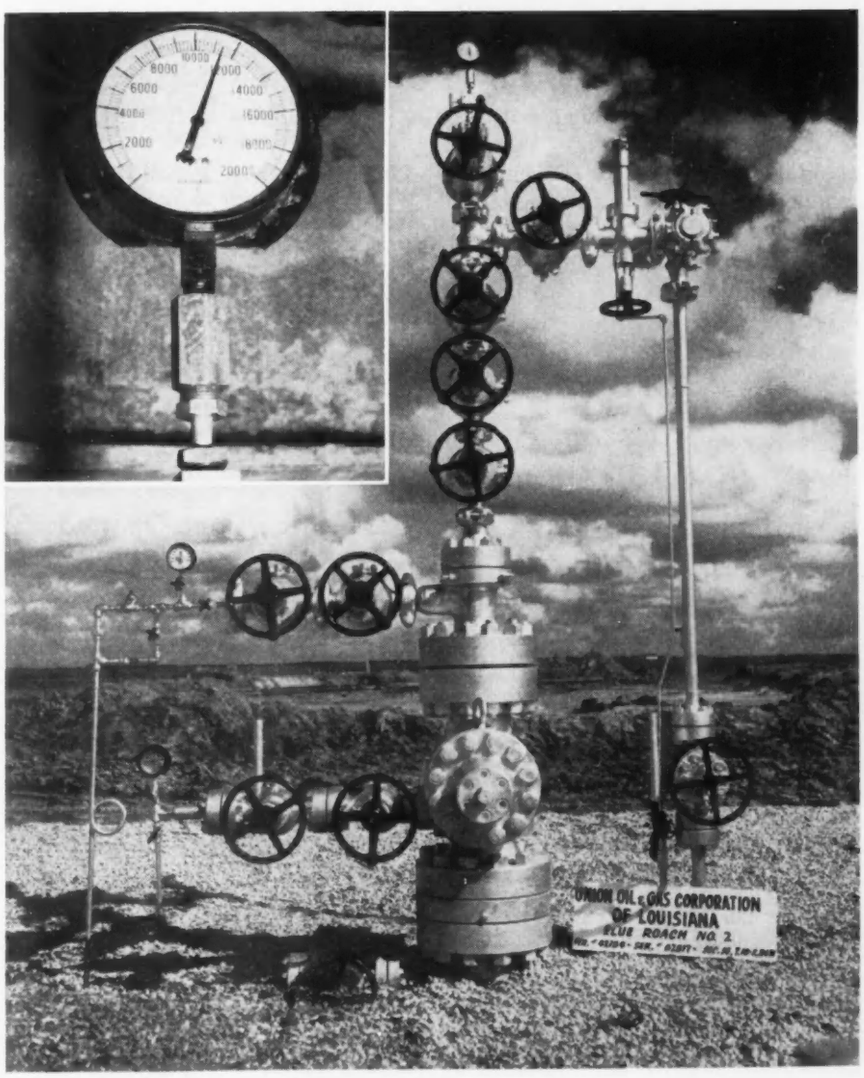


FIGURE 1—Here is a typical South Louisiana high-pressure gas well. Surface tubing pressure, as shown in the inset, is 11,400 psi. The ½-inch connections tied into the 2⅞-inch tubing wing are used for inhibitor injection.

surface pressure had increased to 5,100 psi. Final shut-in pressure was 6,500 psi. Because of this unexpected pressure, it was necessary to kill the well and install a heavier Christmas tree. Subsequent wells completed in this same field in deeper reservoirs (11,000 to 15,000 feet) have had bottom hole pressures of 8,700 to 12,200 psi and surface pressures of 6,400 to 10,100 psi.

These wells were corrosive and treatment was difficult since it was necessary to run tubing and production packer to prevent exposure of the oil casing string to the abnormally high pressure. Thus, one of the greatest operating dangers was a tubing leak or mechanical failure close to the surface, which would have resulted in excessively high pressure on the oil string and made well control very difficult.

In 1948, casing pressure was found building up on Gueno 3. Subsequent investigation showed that holes in the tubing caused by corrosion were responsible. Since the tubing leak was fairly close to the surface, the well could not be killed in the conventional manner by forcing heavy mud down the tubing. So, it was necessary to snub a string of 1¼-inch drill pipe into the hole under pressure to approximately 8,100 feet. The well then was killed with heavy mud.

The workover was responsible for installation of the first kill string. It was believed that 1¼-inch pipe would do the job, whether snubbed or installed permanently in the well. Obviously, a permanent kill string afforded many advantages over the snubbing procedure. If a permanent installation was made, and it became necessary to kill the well, it could be done either by pumping down the 1¼-inch string and back through the 1¼-2⅞-inch annulus, or pumping down the annulus with returns through the 1¼-inch pipe. Therefore, on recompletion, 2⅞-inch tubing was set on production packer and a 1¼-inch tubing string was swung open ended at about 7,500 feet. This is thought to be the first completion using an inside string of 1¼-inch tubing for control of a high pressure gas well.

In 1951, similar difficulties occurred with another well in Branch field. The well had a shut-in pressure of 6,800 psi and had developed pressure on the casing from a split in the 2⅞-inch tubing string. Again, it was necessary to snub a 1¼-inch string of drill pipe into the well. On recompletion, a 1¼-inch tubing string was installed since its previous use in Gueno 3 appeared satisfactory.

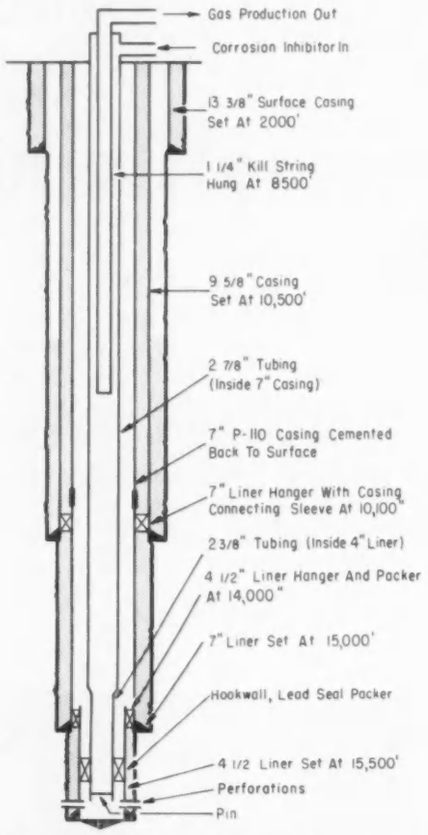

Gas Production Out
Corrosion Inhibitor In
13 3/8" Surface Casing Set At 2000'
1 1/4" Kill String Hung At 8500'
9 5/8" Casing Set At 10,500'
2 7/8" Tubing (Inside 7" Casing)
7" P-110 Casing Cemented Back To Surface
7" Liner Hanger With Casing Connecting Sleeve At 10,100'
2 3/8" Tubing (Inside 4" Liner)
4 1/2" Liner Hanger And Packer At 14,000'
7" Liner Set At 15,000'
Hookwall, Lead Seal Packer
4 1/2 Liner Set At 15,500'
Perforations
Pin

FIGURE 2—Deep, abnormally pressured wells are equipped as indicated if drilling conditions permit. Although kill strings normally are hung at 7,500-8,500 feet, at least one has been installed to 13,600 feet.

Contour Line Omitted

A contour line was inadvertently omitted from Figure 2, Isopach Map of Devonian, Page 99 of the September 1960 issue of WORLD OIL, in the article "Northern Arizona has good oil, gas prospects." The value (500 feet) was drafted onto the map but the contour loop was not. This loop has a roughly parabolic shape with the long axis running slightly northwest of due east-west. The contour's east limit comes almost to the Navajo-Coconino County line. Its south and west limits fall short of the dry holes shown in northern Yavapai County.

The authors requested this correction since this isopach value is one of the more important findings in the subsurface work from which the article was developed. A Devonian depositional basin lying south of Flagstaff, not heretofore outlined, has been located by the authors.

In 1952, development commenced in Lake Arthur field, Jefferson Davis Parish, Louisiana, which was a known high pressure area. At that time, the concentric tubing completion or kill string was adopted as standard completion procedure. Figure 1 shows the wellhead hook-up of a typical high pressure well.

COMPLETION PROCEDURE

As a matter of policy, the 1¼-inch tubing string now is installed in all wells where a closed-in surface tubing pressure of 6,000 psi or more is expected. To date, 43 wells have been completed in five fields by this method with surface pressures ranging to 13,000 psi. Normal practice is to run the 1¼-inch pipe from 7,500 to 8,500 feet. However, one string has been installed to 13,600 feet. Figure 2 shows a typical installation.

Upon reaching total depth and prior to completing high pressure gas wells, mechanical well conditions, depth, the objective sand or sands to be tested and anticipated pressures are reviewed. In this respect, formation pressures have been estimated successfully from curves reflecting the increase in abnormality of pressures with depth for the field or area concerned.

Typical program. Union Texas has adopted a general tubular program for deep (15,000 feet +), high pressure wells. The following procedure is applied if well conditions permit.

A 12¼-inch hole is drilled from beneath 13⅜-inch surface pipe (set at 2,000 feet) to 10,500 feet where a protective string of 9⅝-inch casing is set and cemented. Additional hole is drilled and 7-inch liner is installed at approximately 14,000 feet (sooner, if required for well control), as a protective measure for future drilling.

Since the 9⅝-inch string has been exposed to considerable wear from the drilling operation, a long string of 7-inch casing is run and tied into the 7-inch liner as a safety measure. Drilling then is continued through the lowermost zone of interest and a 4½-inch or 5-inch liner is run, hung and cemented inside the 7-inch for completion purposes. Since the 7-inch casing string previously tied into the 7-inch liner also has been subjected

to wear due to additional drilling, it is pulled and replaced with new 7-inch, P-110 pipe. This new string then is cemented to surface inside the 9⅝-inch casing. Prior to running in the hole, the casing is tested on the rack with hydraulic pressure to 80 percent of its minimum yield (12,500 psi for 35-pound, P-110 casing). Pipe is set in tension to minimize the possibility of buckling from thermal expansion which can be caused by high formation temperatures or increased well temperatures due to producing gas at high flow rates.

After conditioning mud and jet perforating the objective section (usually 4 shots per foot), a combination tubing string is run and set on a production packer approximately 30 feet above the top of the perforations. Two and one-half-inch tubing is used in the 7-inch casing and 2-inch inside the 4½-inch liner. Before running tubing, it is tested with hydrostatic pressure to 80 percent of its minimum yield and the ends are further checked by magnetic inspection. After making up each joint, the connection is hydrostatically tested to 15,000 psi (for 7.9 pound, P-105 tubing).

After setting 2⅞-inch tubing, the 1¼-inch string (also hydrostatically tested and inspected on the ends) is run to 7,500-8,500 feet and hung open ended.

In this manner, the two tubing strings and Christmas tree are fully connected and the well completely "buttoned up" before any attempt is made to wash it in. Before displacing, a plug is set in the bottom of the Christmas tree and the tree and flow line to the heater are tested with hydraulic pressure to 15,000 psi or the necessary pressure for the particular well concerned.

When mud is displaced with water, the hydrostatic head of the fluid column is reduced sufficiently so that the well will flow. It should be noted that the well is under complete control at all times which represents maximum safety in well completion. This procedure, of course, requires time and excellent supervision. When dealing with abnormally high pressures, experience has shown that good materials and the best of supervision are prime requisites. There are few advisable short cuts and in the long run the safest procedure is the cheapest.

Upon completion, each well is equipped for production with a high-low safety valve on the Christmas tree.

PRODUCTION

Normal procedure is to produce the well through the 1¼-inch string and to inject corrosion inhibitor with a high pressure chemical pump into the 1¼-inch–2⅞-inch annulus. Based on iron titrations and visual inspection, this treatment has been fairly successful to date. One advantage of flowing the well through the 1¼-inch tubing is that if corrosion does occur, leaks will develop in the inner (1¼-inch) string instead of the 2⅞-inch tubing. Even if a hole should develop in the 1¼-inch pipe, the 7-inch string still would not be subjected to well pressure.

Friction factor curves have been developed for 1¼-inch tubing by observing numerous rates of flow and checking flowing and shut-in surface pressures with a dead-weight gage. This information has been most helpful in detecting failures or holes in the 1¼-inch string. Since various lengths of 1¼-inch tubing are installed and different flow capacities and extremely variable rates of flow result, changes in the pressure drawdown indicated by the surface flowing pressures often do not reflect possible holes in the 1¼-inch string. However, from time to time surface pressures and respective rates are checked against drawdown curves determined previously. If the tubing has developed a hole, it will be indicated by a decreased friction loss for the length of tubing and the rates concerned for that well.

Initially, there was concern over the flow capacity of the 1¼-inch tubing as compared to larger ID pipe. That is, it was not known whether the smaller kill string could deliver adequate production during periods of peak demand. Of course, the rate of flow or capacity also depends upon several additional factors such as length of tubing, reservoir pressure, productivity index, maximum advisable drawdown, etc.

To date, Union has produced at rates of 12.5 to 13.0 MMcfd through 1¼-inch tubing strings. By producing these same wells through both the 1¼-inch–2⅞-inch annular space and the 1¼-inch string, flow rates of 21 MMcfd have been obtained (Figure 3). These maximum rates were

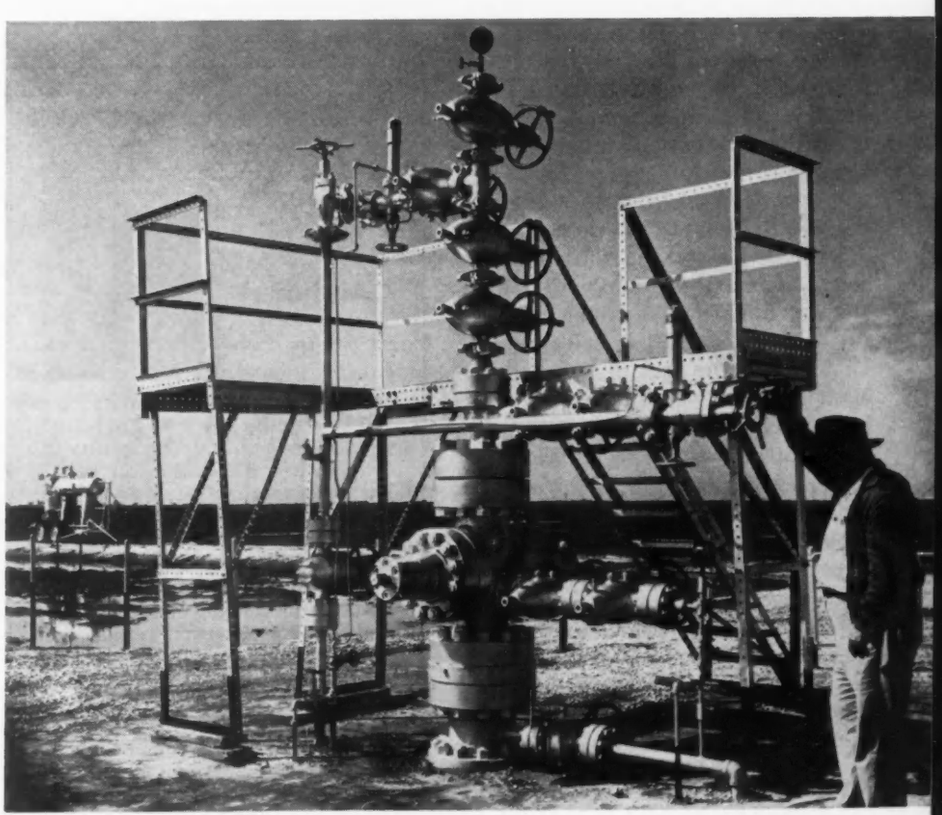


FIGURE 3—This well has been equipped to produce from both the 1¼-inch kill string and the 1¼-inch—2⅞-inch tubing annulus. Also, the 7-inch casing wing is tied into the field gas system so differential pressure on the oil string may be maintained at a safe level during periods of high flow rate and high temperatures.

obtained at a flowing pressure of 2,000 psi from a closed-in tubing pressure of approximately 7,350 psi.

With increasing rates of production there is, of course, a noted increase of surface temperature. Temperatures range from 150 to 160 degrees at 4 to 6 MMcfd to approximately 190 degrees at the higher rates. Of course, it is not possible to continue inhibitor treatment while producing through the annular space. If this condition is expected to continue for prolonged periods, chemical is squeezed into the formation as a batch treatment at periodic intervals.

When producing at these high rates and temperatures, casing pressure is increased due to thermal expansion. This pressure is checked carefully and bled off at proper intervals to keep it from increasing to a dangerous point. Reducing the rate of flow results in a decreasing flow stream temperature with an accompanying decrease in casing pressure. Casing is tied into the field gas line so that when pressure begins dropping, it can be increased as desired to maintain a proper differential between the 2⅞-inch tubing and that inside the production casing string.

Case histories. In Lake Arthur Field, Union has 36-high pressure gas wells equipped with kill strings. It is standard procedure to pull 1¼-inch tubing for inspection and check the Christmas tree on at least one well per year. Normal practice is to select the oldest well, or the one with the most gas production that has not been inspected previously. To date, kill strings have been changed out in two wells. One of these had produced 17 billion cubic feet of gas and the other 14.4 billion cubic feet. On this latter well, only a portion of the tubing string had to be replaced.

In seven years, 13 high pressure wells have been worked over to repair tubing leaks or to inspect Christmas trees and 1¼-inch tubing for corrosion. Twelve wells were killed with no difficulty. In one well, the 1¼-inch hanger flange and seal were cut out making it difficult to circulate down the small string and out the 1¼-inch–2⅞-inch annular space. However, trouble was minor compared to which would have been experienced had the well been equipped with only one string of tubing.

Two wells, with 10,000 and 13,000 psi wellhead pressures respectively, have been worked on successfully. On the 10,000 psi well, a leak in the 2⅞-inch hanger bushing resulted in a pressure build-up on the oil string. Water was pumped in the 1¼-inch string, and gas was bled from the 2⅞-inch tubing until water was circulated around. The water then was replaced with 18.5 ppg mud in the same manner.

The 2⅞-inch string was shut in, the 18.5 ppg mud was squeezed down the kill string and gas below the 1¼-inch was displaced back into the formation. However, the hydrostatic head of 8,500 feet of 18.5 pound mud was sufficient to control the well and no excessive pressures were required. The well was killed in less than 12 hours.

The highest surface pressure encountered to date was 13,000 psi in the Leleux field, Vermilion Parish, Louisiana. Since no market existed for the gas, it was necessary to leave the well shut-in. However, the company considered leaving 13,000 psi pressure on a shut-in well a considerable risk.

After investigating several types of fluids, it was decided to load the well with 10 ppg $CaCl_2$ solution to reduce surface pressure. In this instance, the $CaCl_2$ solution was pumped into the annulus of the 2⅞-inch tubing, while the well produced through the 1¼-inch. $CaCl_2$ then was circulated around the bottom of the 1¼-inch at 8,770 feet. Pump pressures slightly in excess of 13,000 psi were required to start pumping-in. An unsuccessful attempt was made to squeeze the $CaCl_2$ to bottom. However, the solution was displaced successfully to the bottom of the kill string. Surface pressure was reduced to approximately 10,200 psi with the $CaCl_2$ solution and could have been reduced further by replacing the $CaCl_2$ with heavy mud in the same manner.

It is felt that surface pressures in the range of 13,000 psi are at the upper limits for 2⅞-inch, 7.9 pound, P-105 tubing. The smaller ID of heavier tubing of the same size would prohibit installation of the 1¼-inch inside tubing string. Therefore, if higher pressures are anticipated, 3½-inch, 15.37 pound, P-105 pipe will be used. This will allow installation of either 1¼-inch or 2⅜-inch OD kill strings.

Disadvantages. Bottom-hole pressures cannot be obtained since the 1¼-inch tubing will not accommodate a high-pressure bottom hole pressure bomb. However, since surface pressures are extreme, Union does not consider it good practice to run a bottom-hole pressure bomb and wireline into the well even if the tubing were large enough. In order to evaluate reservoir performance, shut-in tubing pressure is determined with a dead-weight gage and the bottom hole pressure is calculated from the shut-in pressure.

The estimated additional cost for this type completion including material and rig time is $16,000-$20,000. This expenditure is considered justified by the additional safety provided during completion, the advantage in killing the well for corrective measures or mechanical repairs and the ability to treat for corrosion by injection of inhibitor into the annular space.

In conclusion, Union has been extremely well satisfied with this completion and production procedure since it affords one of the safest methods for dealing with high pressure wells. In addition, it is felt that safe procedures, good materials and excellent supervision are prime requirements for any high pressure well completion. —The End

About the Author

W. D. Smith, Jr., was graduated from Louisiana State University in 1934 with a B.S. degree in petroleum engineering. He then joined Shell Oil Company. He transferred from Shell to Stanolind Oil and Gas Company, being assigned to Southeast Texas and South Louisiana as junior and field engineer, and in the Houston production office as assistant division engineer. He joined Union Sulphur Company, Inc., as chief engineer in 1945, and occupies that position with its successor company, Union Texas Natural Gas Corporation. He is a resident of Houston and a member of AIME, API, AAPG, Houston Engineering and Scientific Society, and Houston Geological Society.

SOUTH TEXAS / GULF COAST REPORT

Casing failures caused by thermal expansion

Casing strings must be adequately designed to withstand forces other than burst and/or tensile

By H. C. Humphrey, Assistant District Superintendent
Texaco Inc., Liberty, Texas

CASING STRINGS normally are designed to withstand anticipated collapse, burst and/or tensile forces. Heretofore, these forces have been the only ones considered in casing string design. However, several casing failures occurring in South Texas have focused attention on analyses of the causes.

Considerable data on drilling temperatures, normal temperature gradients, and producing temperatures (Figure 1) have been obtained and analyzed. This information indicates the temperatures at which casing was set were below that of the normal formation gradient and that the producing gradient often results in temperatures of 100°F above normal at the surface. This means that, in most cases, the casing string is set at a temperature much below any that it will be exposed to or retain from this point on.

So far as known, none of the known casing failures has resulted from collapse, burst or tensible forces, but were of compression in nature.

These compression failures (See Figure 2) were present in the form of:

- Hoop stress (telescoping of coupling)
- Buckling to the point of collapse or breaking
- Buckling due to mud weight
- Buckling due to thermal compression.

Any slackening off of tension in the long firm shale sections through which the intermediate casing string is set in deep wells will promote buckling due to the lack of horizontal support. This buckling causes undue wear to both casing and drill pipe in drilling out under the intermediate string.

Factors causing compression or buckling failures include:

- Increased mud weight

According to Arthur Lubinski's article, "Influence of Tension and Compression on Straightness and Buckling of Tubular Goods in Oil Fields," if the density of the fluid inside the casing is much greater than the density of the external fluid, the freeze point must be subjected to a large amount of tension to avoid buckling.

Example:

1. Casing: 7-inch OD 23 pounds per foot.
2. Density of external fluid: 10 ppg.
3. Density of internal fluid: 18 ppg.

Initial stress at the top of the casing in this example was equal to 4,850 psi per 1,000 feet of free length. If the freeze point is located at 7,000 feet, the critical stress at the top of the casing is equal to 33,950 psi. As the casing wall cross-sectional area is equal to 6.66 square inches, the critical stress of 33,950 psi corresponds to a force of 33,950 x 6.66, or 226,000 pounds. The casing will buckle when the casing head load is smaller than 226,000 pounds.

To prevent buckling from the mud weight alone, as in the above example, the casing would have to be hung at 43 percent in excess of the weight of the pipe. The surface weight indicator should read 226,000 pounds, as compared to pipe weight of 160,000 pounds.

- Forces of thermal expansion

When the temperature of casing is changed, the casing will expand or contract in an amount determined by the following equation:

$$e = n\,l\,t$$

e = linear expansion

t = change in temperature

n = coefficient of thermal expansion

l = length of casing

Any increase in temperature will increase the length of a string of casing. However, the lengthening is restricted because the bottom is cemented and the top is securely fastened at the bradenhead. This lengthening condition results in the slackening off of tension and generally is transmitted and concentrated in the lowermost free section of the string in the form of compression buckling. The effects of this condition are more critical in long intermediate and oil strings of 10,000 feet or more because the effects discussed by Lubinski will be compounded with the force of thermal expansion, and

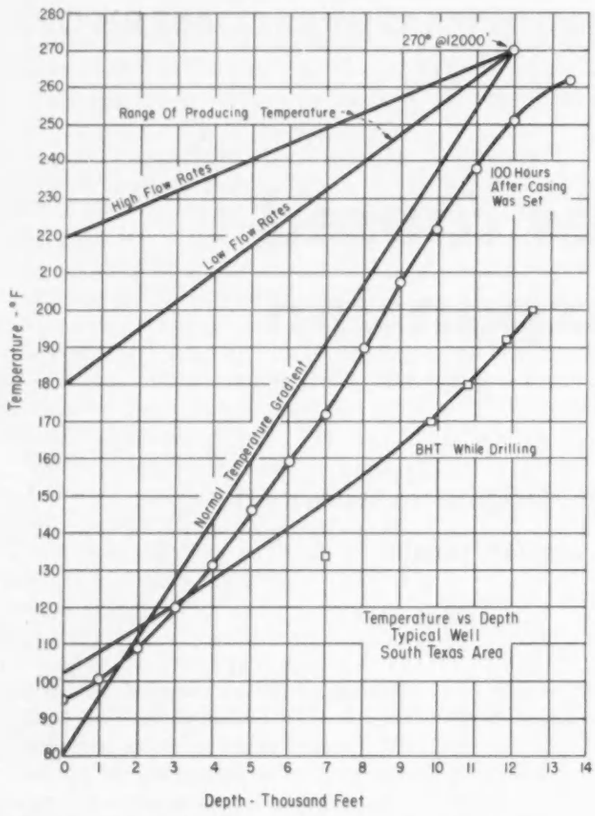


FIGURE 1—Casings are subjected to a wide temperature range between drilling and producing temperatures.

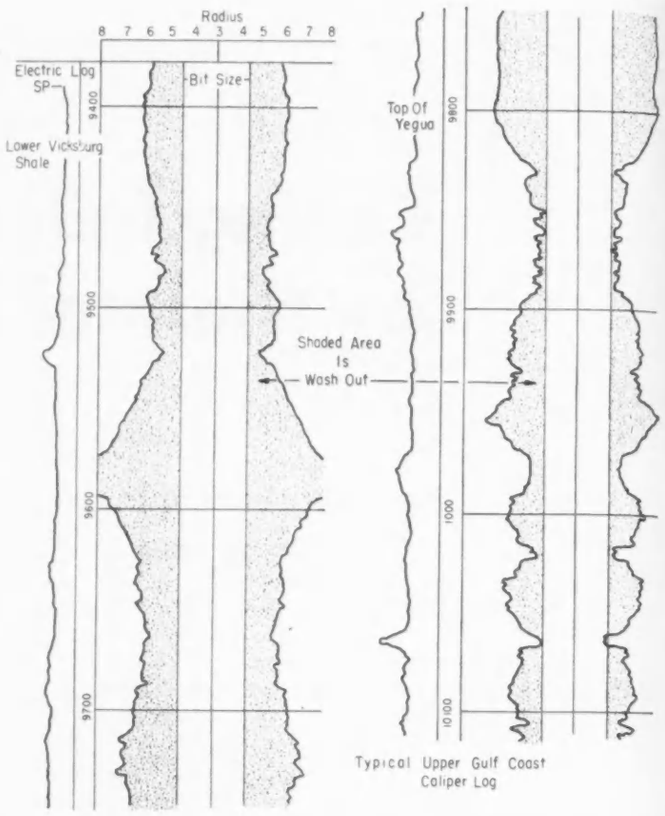


FIGURE 3—Caliper surveys indicate zones lacking horizontal support for casing strings.

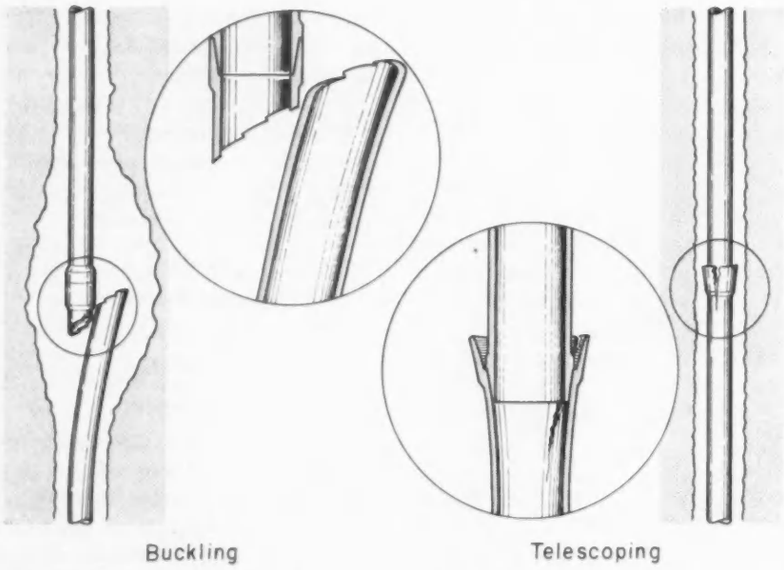


FIGURE 2—Thermal expansion causes typical buckling and telescopic casing failures.

it is this composite force that will have to be dealt with.

In estimating thermal compressive forces, the following rule of thumb may be used:

> For each 1°F change in temperature, the compression changes 207 psi.

The temperature of the lower most part of the hole may not exceed 180°F at the time the pipe is run and cemented. This temperature often is 60° to 80°F below that of the normal formation. Upon completion of the well, the producing temperatures may increase as much as 100°F at the surface, thus creating an overall increase of temperature on the casing strings of 60° to 120°F. This temperature increase creates the problem of keeping the stresses in the pipe below the failure point in the area immediately above the freeze point.

When will increasing temperature cause the casing to buckle? Buckling failures are appreciably influenced in accordance with the cementing programs, cement slurry, mud weight inside and outside of the casing string. These conditions will all affect the buckling temperature of the casing. At shallower depths, when the surface pipe is cemented back to the surface and lower temperature does not exert as great a thermal force of the casing, no failures have occurred. Failures have occurred on the long intermediate strings which penetrate firm shale sections that are not covered with cement. Usually these sections have high wash-out characteristics and a lack of horizontal support results (See Figure 3).

As will be noted on the attached sample log, the shale sections have

much larger hole diameters than do the sand sections which conform more closely to bit sizes.

Example 1—Sample Calculations. To determine stress in 7⅝-inch - 29.7 pounds per foot casing at the cement freeze point: Casing is set in full tension. Mud weight and slurry weight 12.4 ppg. 12,000 feet of casing is to be run with top of cement to be at 6,000 feet.

A. Critical stress at the freeze point calculated from Lubinski's Formula No. (1)

$$\frac{s_f}{L} = -52\left[de - \frac{d_i - d_e}{R^2 - 1}\right]$$

where:

d_e and d_i = the density of fluid outside and inside the casing string respectively, in pounds per gallon.

R = Ratio outside diameter to inside diameter of the casing.

L = Free length, in thousands of feet.

s_f = Critical stress at the freeze point at which buckling will start.

(s_f positive is a tension, and s_f negative is a compression.)

Transposing Formula No. 1:

$L = 6$ free lengths in 1000 feet
$d_e = 12.4$ external fluid density
$d_i = 12.4$ internal fluid density

$$s_f = -52L\left[d_e \frac{-d_i - d_e}{R^2 - 1}\right]$$

Sub. $$s_f = -52 \times 6\left[12.4 \frac{-12.4 - 12.4}{R^2 - 1}\right]$$

$$s_f = -52 \times 6\ [12.4 - 0] = -3868.8 \text{ psi}$$

B. 7⅝-inch - 29.7 pounds per foot casing weighs 29 pounds per foot when submerged in 12.4 ppg mud or cement.

Tensile stress at freeze point due to weight of casing in psi =

$$\frac{\text{length of casing hanging below freeze point} \times \text{wt/ft of casing in fluid}}{\text{cross sectional area of casing}}$$

$$= \frac{6000 \times 29}{8.56} = 20{,}300 \text{ psi}$$

C. Total stress change available before buckling starts = Critical compressive stress + tensile stress from differential weight of fluid column + tensile stress from casing weight in fluid column.

Total stress = 3869 psi + 0 + 20,300 psi = 24,169 psi

D. Therefore:

$$\frac{\text{Total stress change available}}{\text{Stress psi/°F. Temp. Change}} = \frac{24{,}169}{207}$$

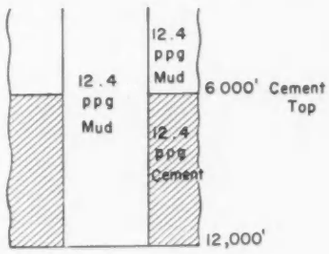
= 117°F temperature rise available before buckling starts.

The calculated stress in the 7⅝-inch - 29.7 pounds per foot casing using a slurry weight and mud weight of 12.4 ppg was made. The following stresses were obtained for the case where 12,000 feet of this casing was cemented back to 6,000 feet. Using Formula 1 in Mr. Lubinski's article, the critical stress at the freeze point for which buckling starts was a compressive stress of 3,869 psi. The tension in the casing at the freeze point at the time of cementing was 20,300 psi.

This will give a total stress change available before buckling starts of 24,169 psi. Dividing this stress by a stress of 207 psi will give the temperature increase this casing will stand before buckling starts, which is 117°F. If the temperature increase is less than 117°F, no buckling of this casing should occur.

EXAMPLE 1
SUMMARY OF PREVIOUS CALCULATIONS

Buckling temperature 117°F



Conditions

A Size of casing—7⅝-inch

B Weight of casing—29.7 pounds per foot

C Using Lubinski's equation 1 (Reference 1)

D 12.4 ppg cement slurry and mud weight.

Results

A Critical compressive stress at the freeze point—3,869 psi

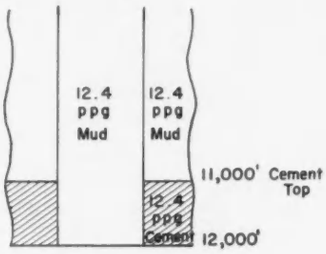
B Casing tension at the freeze point when cemented—20,300 psi

C Stress change available before buckling starts—24,169 psi

D Temperature increase before casing will buckle—24,169/207 = 117°F

EXAMPLE 2

Buckling temperature—50°F



Conditions

A Size of casing—7⅝-inch

B Weight of casing—29.7 pounds per foot

C Using Lubinski's Equation 1 (Reference 1)

D 12.4 ppg mud and cement slurry weight

Results

A Critical compressive stress at the freeze point—7,093 psi

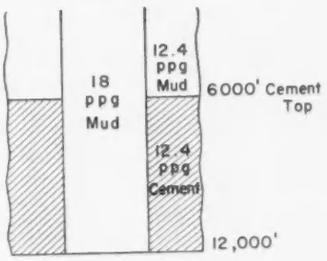
B Casing tension at the freeze point when cemented—3,388 psi

C Stress change available before buckling starts—10,481 psi

D Temperature increase before casing will buckle—50.6°F

EXAMPLE 3

Buckling temperature—88°F



Conditions

A Size of casing—7⅝-inch

B Weight of casing—29.7 pounds per foot

C Using Lubinski's Equation 1 (Reference 1)

D 12.4 ppg annulus mud and cement slurry, 18 ppg mud inside casing.

Results

A Critical tensile stress at the freeze point—3,713 psi

B Tensile stress at the freeze point when cemented—20,300 psi

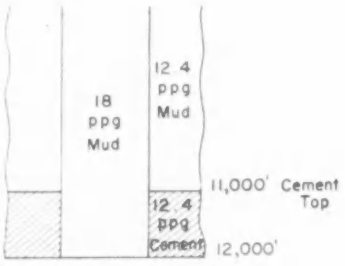
C Tensile stress due to hydrostatic differential 2,274 psi

D Stress change available before buckling starts—18,861 psi

E Temperature increase before casing will buckle—18,861/207 = 91°F

EXAMPLE 4

Buckling temperature—4.2°F



Conditions

A Size of casing—7⅝-inch

B Weight of casing—29.7 pounds per feet

C Using Lubinski's Equation 1 (Reference 1)

D 12.4 ppg annulus mud and cement slurry, 18 ppg inside casing.

Results

A Critical tensile stress at the freeze point—6,688 psi

B Tensile stress at the freeze point when cemented—3,388 psi

C Tensile stress due to hydrostatic differential—4,170 psi

D Stress change available before buckling starts—870 psi

E Temperature increase before casing will buckle—870/207 = 4.2°F

General casing practices. Normally, a string of casing is hung with full weight tension and is run at a temperature gradient less than that of the formation through which it is set. Present practices are to avoid compression stresses. The lower temperature is brought about by the cooling effect exhibited by the circulating of the drilling fluid.

Although the casing was hung with full weight tension, it already has started into compression towards the bottom as soon as it is cemented. Loss of weight on the weight indicator verifies this fact.

When the well has been completed and placed on production, another sharp increase in temperature will subject the pipe to a critical compression. This variance in temperature condition is shown in Figure 1. This temperature range may be as much as 100°F or more above the weighted temperature at which the casing was run and cemented.

Field observation. In three fields in South Texas, buckling and telescoping type of failures were observed. In this area, 5½-inch oil strings are set at approximately 12,300 feet while 7⅝-inch intermediate strings are set at around 11,600 feet.

Coupling failures appeared in both strings of casing just above the top of the annular cement returns. Apparently, the pipe was sufficiently supported laterally through the cemented interval to restrain the expansion forces and telescopic failures. However, as soon as these forces passed into an unsupported interval, fatigue stresses were set up in the tubular coupling, and failure occurred.

Buckling type failures also were observed in the intermediate and oil strings that were used to case off the Vicksburg shale interval. After observing this characteristic type of failure and suspecting that the failure resulted from a lack of lateral support, caliper surveys were run on the subsequent wells to determine the extent of washout through the interval that failed.

Figure 2 shows that the hole is approximately three times the original hole size through the interval in which buckling failures had taken place on previous wells. It is believed that if the formation was such that a washout was not present or if the pipe had been cemented through the interval, a buckling failure most likely would not have occurred.

The oil string buckling failures were most prevalent just above the freeze point and inside the intermediate casings.

How to eliminate casing failures

• Proper use of caliper survey

To accurately determine the amount of cement necessary to adequately cement the casing, caliper logs must be evaluated thoroughly. Normally, the practice for determining the cement volume has been to use the rule of thumb, gage hole size plus 10-20 percent washout. However, recent evaluations have indicated that this figure should have been 200-300 percent rather than 10-20 percent. This is most apparent in long shale sections which possess wash-out characteristics such as in sections of the Vicksburg and Anahuac shales.

• Lubinski's buckling failure due to hydrostatic fluid weight

The hydrostatic weight of the fluid should be taken into consideration when designing the casing string. Lubinski's work is clearly outlined with charts, graphs and typical examples in the article previously mentioned.

• Heating the circulating fluid to counter thermal compression

Temperature of the drilling fluid could be increased to a point that it would have a value halfway between that of the normal and producing gradients. In this case, if the well was completed and shut in, the temperature should fall back to that of normal, which would impose an increased tension on the pipe but should not approach a critical value.

• Casing string designed on an individual basis

Every well will have varying conditions. Consequently, each casing operation should be designed for a specific job. All available information should be assembled and evaluated so that temperature variations, lithological wash-out characteristics, running and landing practices, and tensile and collapse stress are understood before the casing is run. From the above, determine proper tension or weight at which the casing should be suspended from the bradenhead.

• Cement intermediate string to surface.

This practice will minimize the possibilities of buckling through the intervals where horizontal forces are not great enough to support thermal expansion conditions. Although this may be a high initial cost, the over-all well life expenditure should be less.

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[2] Evans, George, Engineer, Mechanical and Research Department, Halliburton Company, Inc.

How Conoco makes . . .

Non-commercial field pay off

Unique Southwest Texas production operation features engineered well completions and complete automation-data processing system

By Ronald Casey, Production Engineer, Continental Oil Company, McAllen, Texas

James C. Shepler, District Engineer, Continental Oil Company, Pleasanton, Texas

CONTINENTAL OIL COMPANY has used large volume fracturing treatments to convert a previously non-commercial Southwest Texas oil field into a financial success. As of September 1, 1960, 202 wells with an allowable of 2,535 bopd were producing on the N. J. Chittim lease in Sacatosa field located in Maverick, Dimmit and Zavala counties, Texas. Sixty additional wells have been drilled and completed; however, 51 still are recovering load oil and nine are awaiting fracture treatment. Continental also is installing a unique automation system which provides for complete automatic operation of the field. When completed, the system will permit field data to be transmitted automatically and directly to the company's forthcoming electronic data processing center.

Geology and exploration. Sacatosa field is located on a broad southeast trending anticline known as the Chittim Arch. The initial test was drilled in April 1955, on the basis of an aerial survey which disclosed a surface fault in the central portion of the structure. The well potentialed for 103 bopd from open hole at 3,109-4,134 feet. Production was from the Eagle Ford Shale. During the remainder of the year, two dry offsets were drilled.

A strat test program was initiated in the spring of 1956, and 14 wells were drilled, varying in depth from 1,390 to 4,047 feet. This information provided the structural and stratigraphic control necessary for further evaluation of the lease. One of these strat tests was completed as a gas well in the Plumly field and five others defined the San Miguel sand reservoir, which at that time was not considered commercially significant. As a result of this program, five wells were drilled during the fall of 1956 and spring of 1957; four were dry and one was completed as the discovery well of the Sacatosa (San Miguel-1 sand) field.

The San Miguel-1 sand is a member of the Taylor formation of the Upper Cretaceous system of Mesozoic age. As defined by the strat test program, the reservoir is a stratigraphic trap resulting from a sand pinchout across the arch. It dips structurally at an average rate of 140 feet per mile to an oil-water contact.

Maximum gross thickness of the sand section is approximately 80 feet at the oil-water contact. Net pay averages 22 feet, and is in the upper 25-40 feet of the section. Also, there are limy or hard streaks ranging from one-half to four feet in thickness within the pay section.

Development. The discovery well was drilled and cored with air. As a result, only a small amount of unconsolidated sand was recovered by coring. Original potential was 4 bopd. After shooting with solid nitroglycerin, the well produced 6 bopd.

Because of the well's marginal status, considerable study was made before deciding on a program to evaluate the commercial possibilities of the sand. The program selected called for the immediate drilling and testing of two additional wells using special mud, coring, logging and completion methods.

Wells 37-10 and 37-11 were drilled and completed in 1957 under this program. Well 37-10 was fractured with 22,500 pounds of sand in 16,590 gallons of diesel oil and potentialed for 19 bopd by pump. Three months later, the well was perforated higher in the section and fractured with 75,000 pounds of sand in 51,240 gallons of diesel oil. Following treatment, the well was completed flowing 60 bopd on 11/64-inch choke.

Well 37-11 was fractured with 90,000 pounds of sand in 67,000 gallons of diesel oil and flowed at the rate of 58 bopd on 8/64 choke.

The performance of the three wells in the San Miguel-1 sand then was studied for a year. During this time, Continental's Research and Development Department participated in an extensive study to work out a further program for evaluating the field. This program called for the drilling of six wells, utilizing various completion practices, to determine the economics of further development of the sand and to evaluate the various sizes of fracture treatments.

Fracturing experiment. In August and September of 1958, the six wells were drilled and completed in the San Miguel-1 sand. During the latter part of November and December, the wells were perforated and fractured. Frac treatments varied from 30,000-270,000 pounds of sand.

On March 1, 1959, a six months exemption status was granted to permit field wells to be produced at a rate sufficient to establish a performance trend in a reasonable length of time. This rate was the 20-acre depth allowable of 37 bopd. Based on this information, a study utilizing computer techniques was made which indicated that the optimum fracture size was 40,000-70,000 gallons, with 1½ pounds of 20-40 mesh sand per gallon.

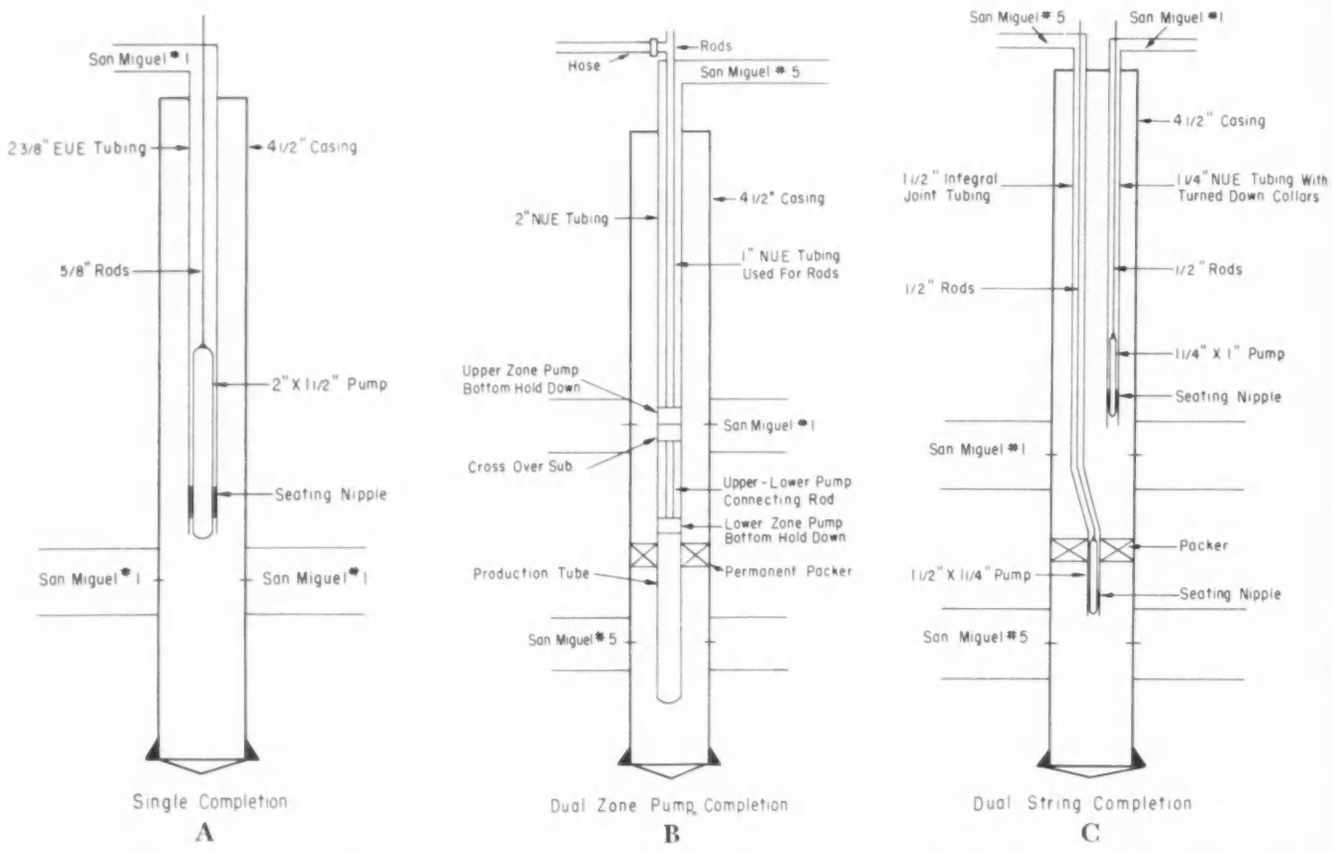

FIGURE 1—Several types of standard completion programs are used in Sacatosa field. Figures 1A and 1B show single and dual pumping wells completed with 4½-inch casing. Figure 1C shows a dual zone pump completion which has been converted to a two string dual. Newer duals are cased with 5½-inch pipe and utilize two strings of 1½-inch tubing.

Drilling and completion procedure. Conoco has adopted standard drilling practices and completion techniques in the area. A 7⅞-inch hole is drilled to TD without surface pipe, the well is logged, cased with 4½- or 5½-inch pipe cemented to surface, and perforated in a single plane for better single horizontal fracture initiation. Tubing is run and the well is fractured and placed on production.

From 1½ to two bits are used per well depending upon depth and rig time is from 24 to 48 hours from spudding to release after setting casing. Well depths range from 1,300 to 1,900 feet. Phosphate mud (11.0 ppg), with a water loss of 4-7 CC, is used in all drilling operations.

The completion method depends considerably on log analysis. A standard program, derived from evaluation of several types of logs, has been adopted. Current practice is to run induction-electrical log and microlog as soon as possible after drilling the well, since long exposure of the formation to mud effects logging results. After casing is cemented, a gamma ray-neutron log is run for depth correlation and perforation placement.

TABLE 1—Average Single Well Cost, Sacatosa Field

Completed Well Cost	$17,000
Lift Equipment	2,400
Automation	1,500
Electrification	450
Roads	150
Lease Miscellaneous	500
	$22,000

Further development of the Chittim lease required careful log study prior to setting casing. The San Miguel-5 sand is found productive on the east edge of the field approximately 300 feet below the San Miguel-1, and all wells with good sand development in both zones are cased with 5½-inch pipe to permit dual completion. In addition, the drilling program is planned to check development of lower sands. Various wells, designated by the geological section, are drilled to a sufficient depth to penetrate the lower zone.

Figure 1 shows three types of completions which have been made in Sacatosa field. Figure 1A illustrates a typical single well completion in the San Miguel-1 sand. Average single well costs are indicated in Table 1.

A typical dual zone pump completion is shown in Figure 1B. This completion procedure has been utilized successfully in several wells equipped with 4½-inch casing. Figure 1C shows a two-string dual completion in 4½-inch casing. As mentioned previously, all new wells set up as two string duals are equipped with 5½-inch pipe. Hook-up is similar to Figure 1C except that 1½-inch tubing is used.

The first wells drilled were completed using 5½-inch casing, since single plane perforating equipment (used for fracture initiation) would not fit in smaller pipe. However, development of the 8-way jet made it possible to complete wells using 4½-inch casing.

The 8-way jet now is used to perforate the casing. If formation breakdown cannot be obtained after perforating with jet charges, the sand jet is used and has proven satisfactory.

Tubing is run before fracturing so the well can be placed on production immediately following the fracture job. However, standard practice is to frac down the tubing-casing annulus for higher injection rates. A repre-

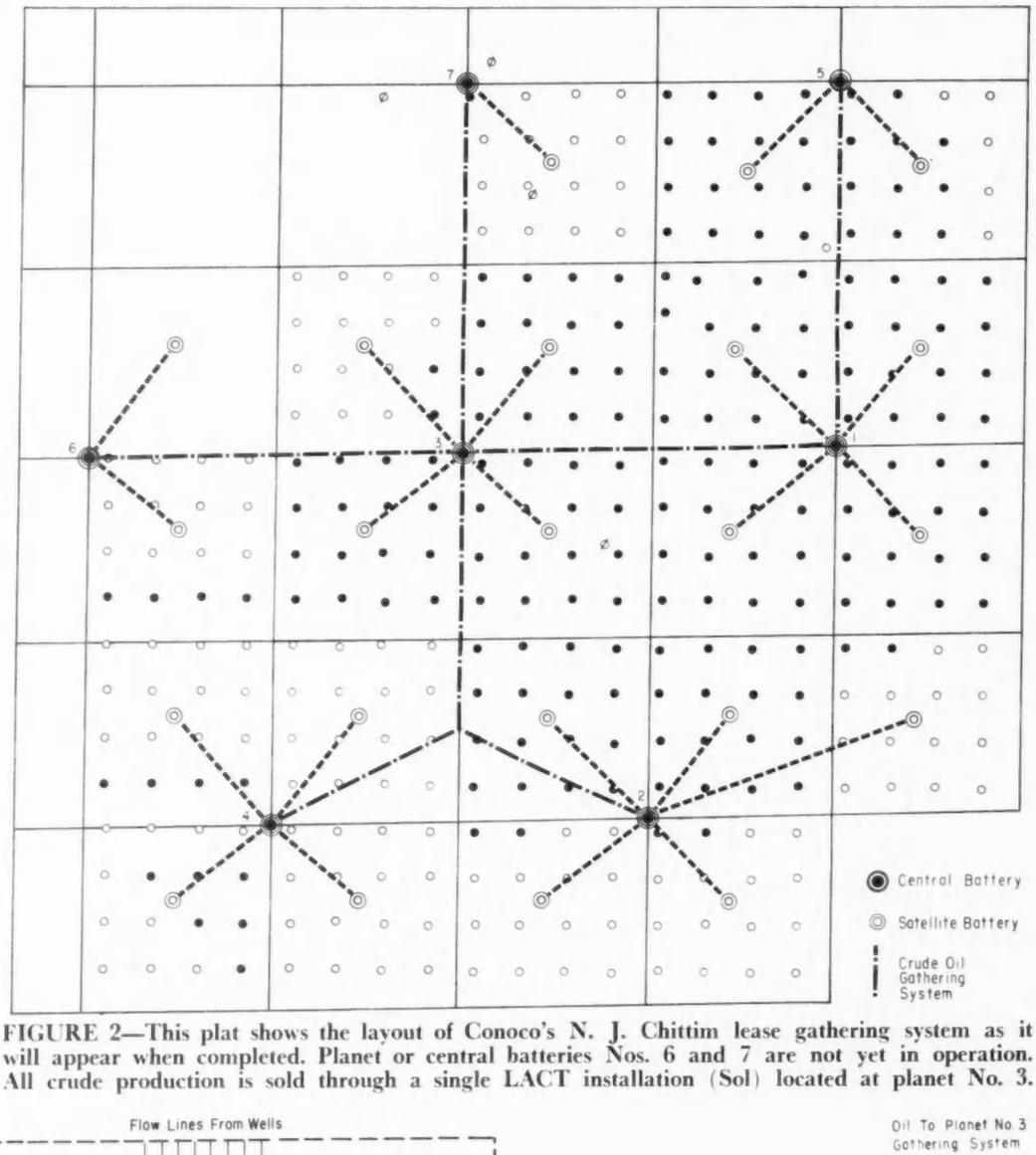

FIGURE 2—This plat shows the layout of Conoco's N. J. Chittim lease gathering system as it will appear when completed. Planet or central batteries Nos. 6 and 7 are not yet in operation. All crude production is sold through a single LACT installation (Sol) located at planet No. 3.

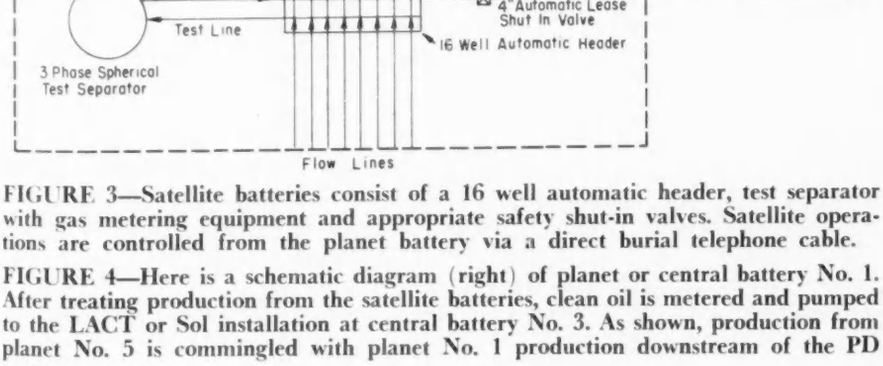

FIGURE 3—Satellite batteries consist of a 16 well automatic header, test separator with gas metering equipment and appropriate safety shut-in valves. Satellite operations are controlled from the planet battery via a direct burial telephone cable.

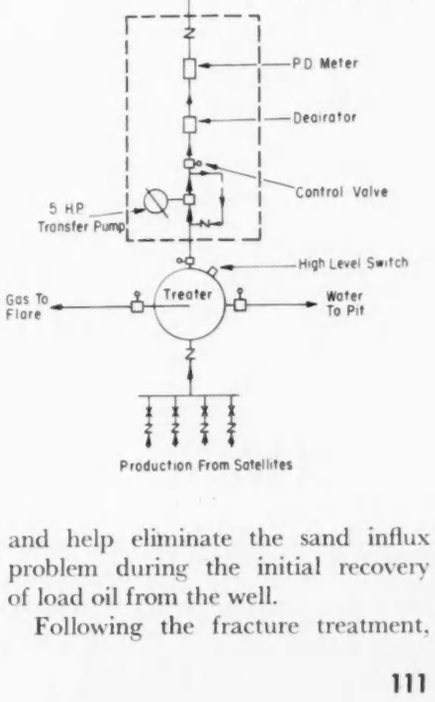

FIGURE 4—Here is a schematic diagram (right) of planet or central battery No. 1. After treating production from the satellite batteries, clean oil is metered and pumped to the LACT or Sol installation at central battery No. 3. As shown, production from planet No. 5 is commingled with planet No. 1 production downstream of the PD meter.

sentative fracture job is as follows:

Pump 30 barrels blanket lease crude treated with 0.10 ppg fluid loss additive to break down formation and establish a pumping rate. Pump 131,500 pounds of 20-40 mesh angular sand and 3,500 pounds of 10-20 mesh sand in the following proportions using lease crude treated with 0.05 ppg fluid loss additive; 5,000 gallons with 1½ ppg sand, 5,000 gallons with 2-ppg, 5,000 gallons with 2½ ppg and 33,800 gallons with 3 ppg sand. The 20-40 mesh sand is followed by 1,200 gallons with 3 ppg 10-20 mesh angular sand to hold the fracture open and help eliminate the sand influx problem during the initial recovery of load oil from the well.

Following the fracture treatment,

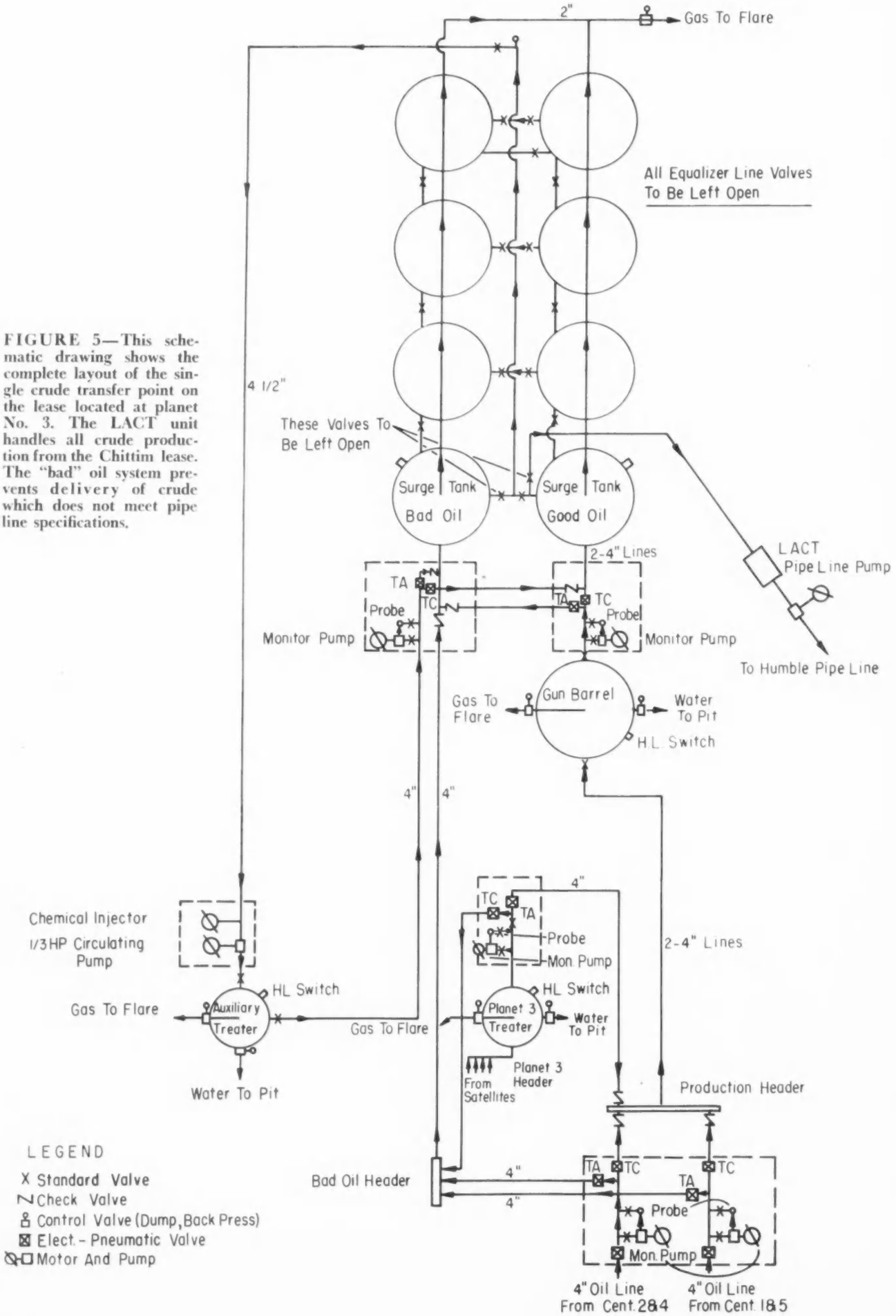

FIGURE 5—This schematic drawing shows the complete layout of the single crude transfer point on the lease located at planet No. 3. The LACT unit handles all crude production from the Chittim lease. The "bad" oil system prevents delivery of crude which does not meet pipe line specifications.

the well is opened for production through a choke to control the return of sand from the fracture. Initial load oil production rate after fracturing usually varies from 100 to 200 bopd.

Production. The original well on the lease, which was completed in the Eagle Ford Shale, produced 23,705 barrels of oil prior to abandonment in January 1959. As of September 1, 1960, cumulative production from the San Miguel-1 sand was 514,995 barrels of oil. All wells were potentialed for 20 to 130 bopd, with over 75 percent above 60 bopd. Cumulative production from the San Miguel-5 sand is 3,003 barrels.

Sacatosa (1,880 feet) lime production has been discovered north of San Miguel-5 sand production. Two wells are completed in this sand with dual zone pumps. Cumulative production as of September 1, 1960, was 10,154 barrels.

Five miles north of the main San Miguel-1 field, the Navarro C-2 sand was found at a depth of 250 feet. This sand has a large areal extent and is approximately 20-feet thick with a permeability of 100 to 300 md. Only one well, with a production of 3 bopd, has been completed in this sand. Different methods of increasing rate of recovery from this reservoir now are under study.

In the northeast part of the lease, there is one well in the Plumly field. This well was completed in a San Miguel section for an initial open flow potential of 4,950 Mcfd in April 1956. Cumulative production to September 1, 1960, was 581,921 Mcf of gas.

AUTOMATION SYSTEM

The large scale development of the field provided the opportunity to utilize extensive automation. Initially, the system was designed for only local automation; however, the most recent design is based on complete data processing.

Automation of lease producing facilities and the handling of the collected data can be divided in the following categories:

- Control and scheduling of oil production.
- Periodic testing of levels in vessels.
- Supervision of levels in vessels.
- Measurement of oil produced and witnessing of its transfer from the lease to the pipe line.
- Automatic use and storage of production data.
- Remote operation and transmission of controls and data.

A time clock located at each pumping unit motor is used to control production. Average wells have a maximum flowing life of from six to nine months. Thereafter, they are put on the pump. All wells are connected into automatic test systems which record test oil, water and gas production. The recording system presents well information on punch tape for automatic handling of data. All vessels have high-level controls which are tied into necessary alarms and shut-in devices.

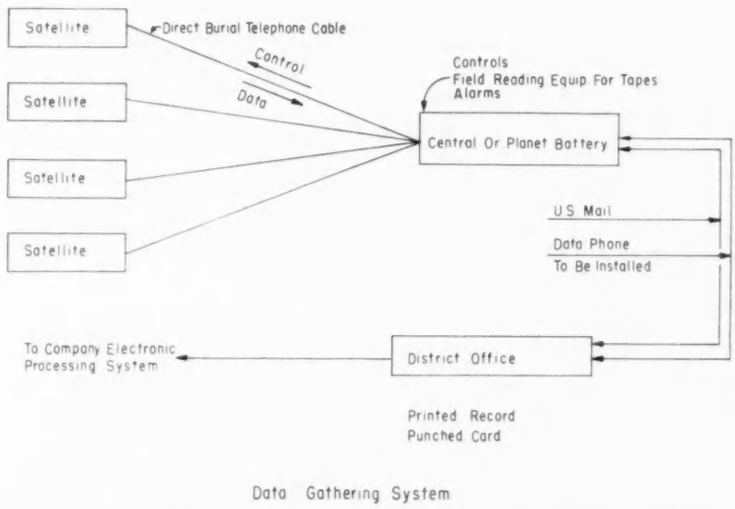

FIGURE 6—Simplified diagram of present data gathering and control system used on Chittim ranch. All operations at satellite batteries are controlled through direct burial telephone cable from the central battery. Test data are transmitted through the same line to the central battery and then to the district office by mail. When data phone is installed to district office, field data can be transmitted by wire direct from the satellite to the district office to Continental's electronic data processing system.

Present gathering system. The basic unit of the automation system is four 640-acre sections, with four satellite batteries and one central control or planet battery. Figure 2 shows the system as it will appear when completed. At present, five of the central installations are operating. Planets 6 and 7 are not yet completed.

The satellite battery consists of the header and test equipment as shown in Figure 3. The present gathering system begins at the satellite battery in the center of each section. The oil, water and gas from 16 wells are combined through the header and delivered through a 4-inch OD line to the central or planet battery. The crude is treated at the planet and the oil, water and gas are separated in a heater treater. Crude is pumped directly from the treater into Humble Pipeline Company's field gathering system now operated by Conoco (See below). A three-way throttling valve is used to automatically recirculate fluid so that the pump can run continuously. The total oil production from each planet is measured before entering the gathering system. Figure 4 shows a typical planet hook-up.

Originally, Humble agreed to gather crude from each of the planets or central points. However, Conoco district personnel and Humble devised a more suitable arrangement whereby Humble would install and maintain a LACT unit at their own expense, if Continental would deliver all crude to only one point on the lease. Thus, Humble installed the unit at Planet No. 3 (Figure 2). Continental then leased the Humble gathering system in the field and all production is delivered to the single LACT unit.

At the LACT point, crude is moved through a 750-barrel capacity gun barrel and a surge tank before being transferred to the pipe line. At this point, BS&W monitors are used to check the BS&W content of the crude. A bad oil system was installed to treat any crude which fails to meet specifications. Figure 5 is a schematic drawing of the transfer point on the lease.

Data gathering system. The data gathering system and the form of

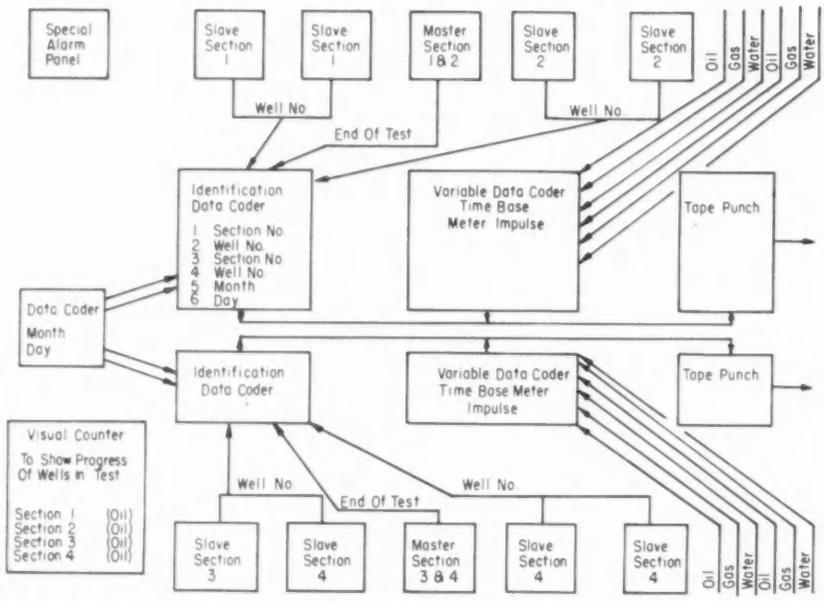

FIGURE 7—Central battery data recording system can accommodate four well tests simultaneously. Visual counter permits pumper to read well test results directly from the control panel.

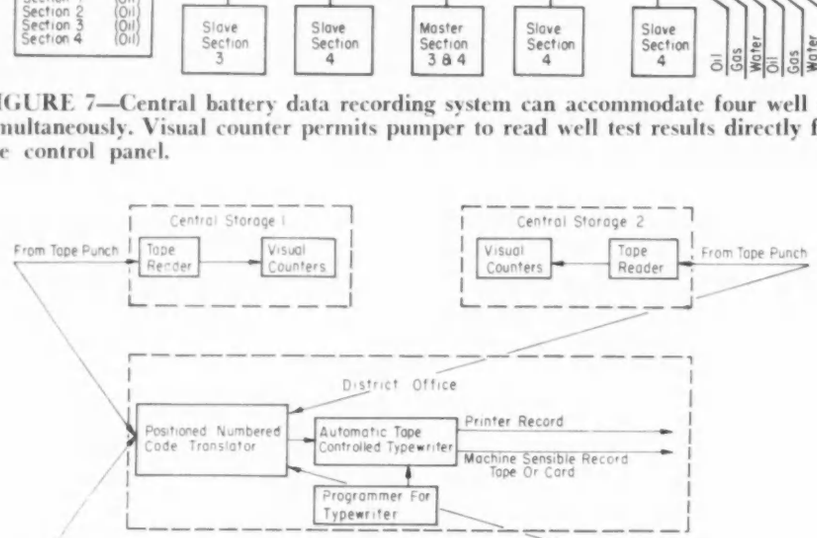

FIGURE 8—Tape punch data from central battery is translated in the district office. Additional information is added at this point, and final data is typed on a hard copy and on machine readable tapes or cards. Final tapes or cards then can be used by Conoco's electronic data processing system.

print out has been revised since the original installation on the lease. The reason for the revision was the need for a more reliable, efficient and cheaper system. Also, the revised hook-up could be tied into the company's proposed electronic data processing (EDP) system.

Data from each satellite is sent to the planet battery through direct burial telephone cable (Figure 6). At this point, data (electric impulses) is transferred to an eight-channel punch tape (mechanical system) which can simultaneously accommodate two well tests. The first, or identification, part of the tape contains well addresses, date and month. The second, or variable data, part of the tape indicates oil, water, gas and time of tests for the two wells. Time is recorded in six minute intervals; therefore, it is possible to tell within six minutes exactly what the wells make. This feature is very important in reducing electric costs and pin pointing pump off conditions. Two tape punch machines are located at each planet; therefore, four wells can be tested at the same time (Figure 7).

Presently, well test tapes are collected and mailed to the district office for processing. Studies now are under way to determine the economic feasibility of transmitting this data to the district office by telephone wire or teletype for tape reproduction.

A special counter panel, installed for the pumper in the field, shows the amount of production a well makes while on test. A reader also has been provided so that the tapes can be decoded in the field. Tapes that are punched in the field cannot be read by standard business machines. In the district office, tapes are run through a translator where additional information is added (Figure 8). All information then is typed automatically on a hard copy and on machine readable tapes or cards. The tapes and/or cards then can be used by the company's EDP center. —**The End**

About the Authors

Ronald Casey was graduated from Texas A&M College in 1957, with a degree in petroleum engineering. He accepted permanent employment with Continental Oil Company in 1956, with leave of absence to complete his college education and fulfill his military obligation. When he returned from service, he completed Conoco's engineer training program and spent one year as an associate engineer. He now is a production engineer in Conoco's McAllen district. He is an engineer-in-training with the Texas Society of Professional Engineers and is a member of AIME.

James C. Shepler received a B.S. degree in petroleum engineering from the University of Kansas in 1955. He then was employed by Continental Oil Company and entered their year's training program. Upon completion of this program, he was assigned to the Rincon District in South Texas as an associate and production engineer. He was promoted to district engineer, Driscoll District, when the development program on the N. J. Chittim Lease began. He is presently district engineer in Conoco's Pleasanton District. He is a member of AIME and API.

Unique wireline workover converts dual to triple well

Success of job due to pressure actuated jet perforator. Gun is set in casing, fired by increase in hydrostatic pressure after wireline is removed from hole

By Gordon S. Rohe,
Petroleum Engineer
Hunt Oil Company, Dallas
Weldon L. Porter, Chief
Well Completion Service
Engineer, Welex, Inc.
Fort Worth

H. L. HUNT has successfully converted a two-string dual completion to a triple producer in Brazoria County, Texas, using only wireline tools and a new pressure actuated jet perforator which remains in the hole after firing. The unique gun was run in the hole, set on bottom opposite the zone to be perforated and wireline tools were removed. After additional wireline work was completed and the well "buttoned up," hydrostatic pressure was increased to fire the gun. The tool permitted Hunt to complete a job (conversion of a normally pressured dual well to a triple producer, with two normally pressured and one abnormally pressured completion) which would have been almost impossible using conventional workover techniques.

Figure 1 shows a schematic drawing of the initial dual completion. In addition to sands E (gas) and F (oil), five additional gas zones were covered by pipe and were potential producers. Although there was a restricted gas market in the field at the time, the lower completion was set up selectively, so that production could be switched from sand F to sands G or J (below F) at a future date by use of wireline equipment only.

It was decided not to perforate sand G or J since an additional well was yet to be drilled, and it was not known whether this well would be completed in sand G or sand J.

At a later date the additional location was drilled and completed in sand D and sand J. The gas market opened up and it was decided to open sand J in the Hunt well for production. A study was made and revealed that the well could be recompleted as a triple producer if special completion tools and techniques were available.

The completion problem was complicated by the fact that bottom hole pressure was normal in sand F (4,848 psi) and abnormal in sand J (6,882 psi).

A conventional wireline workover, which would involve perforating the J sand with a through-tubing gun and installing a pack-off assembly, was undesirable. In this type completion, sand F production (oil, normal pressure) would be crossed into the annulus and sand J production (high pressure gas) would flow through the long tubing string. However, both zones would have to be brought-in concurrently, prior to separation.

This could result in a "charged" oil sand, since the J zone reservoir pressure was approximately 2,000 psi in excess of F sand pressure. Also, the sliding sleeve at 9,513 feet would have to remain open until the pack-off assembly was installed. This could result in the 7-inch casing being pressured to an undesirable point.

The problem, thus, was dependent directly on the perforating procedure. That is, if all wireline work could be performed prior to perforating, including installation of the 1.315-inch OD pack-off assembly, the high pressure gas production from the J zone would be contained within the long tubing string at all times, and no operating problems would exist.

As a solution, a special 10-foot, jet perforating assembly was developed for the job. The perforator was equipped with a hydrostatic firing device, and was designed to be run in the hole and set in casing below the long tubing string prior to installing the 1.315-inch OD pack-off or bypass assembly (Figure 2).

Perforator. As shown in Figure 4, the tool is a completely "free" perforating unit; that is, no shooting line is required for detonation. Also, the gun is designed to remain in the hole after firing.

A "piano" wireline unit may be used to install the tool in the well bore; however, a conventional perforating unit was used on the Hunt job. At present two methods are available for positioning the gun opposite the zone to be perforated:

1. The hanger portion of a through tubing bridge plug may be attached to the tool assembly. The gun is run in the hole on wireline, and "hung" at the proper position.

2. A tail pipe of proper length may be attached to the bottom of the gun. If the zone to be shot is near the bottom of the hole, the tool (with tail pipe) is run on wireline and set on bottom. This method was used on the job described in this article.

After installing the gun in the well bore, remaining well work may be completed.

Referring to Figure 4, the blow plug acts as a trigger mechanism to fire the tool. The particular plug used

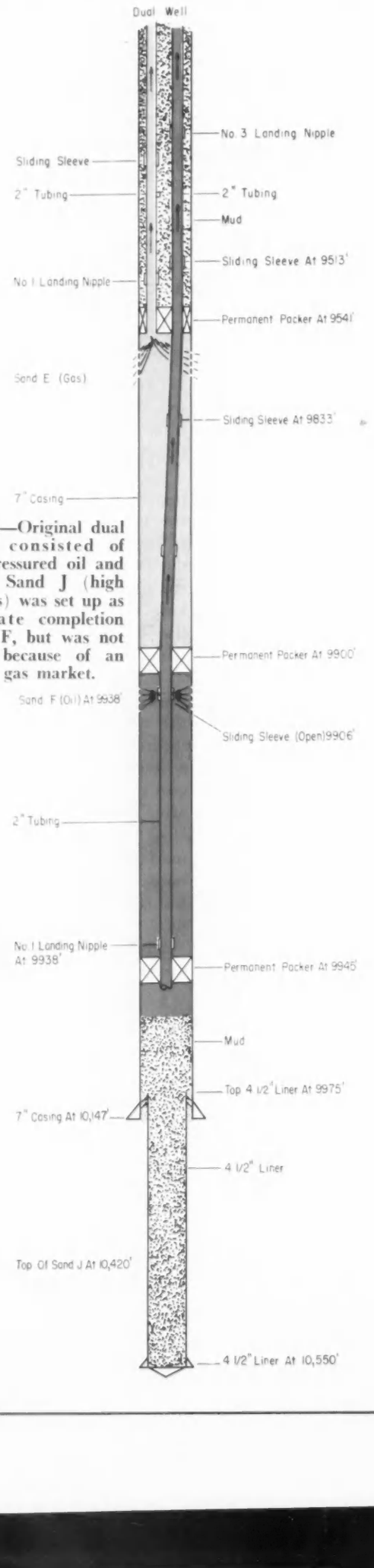

FIGURE 1—Original dual completion consisted of normally pressured oil and gas sands. Sand J (high pressure gas) was set up as an alternate completion with Sand F, but was not perforated because of an inadequate gas market.

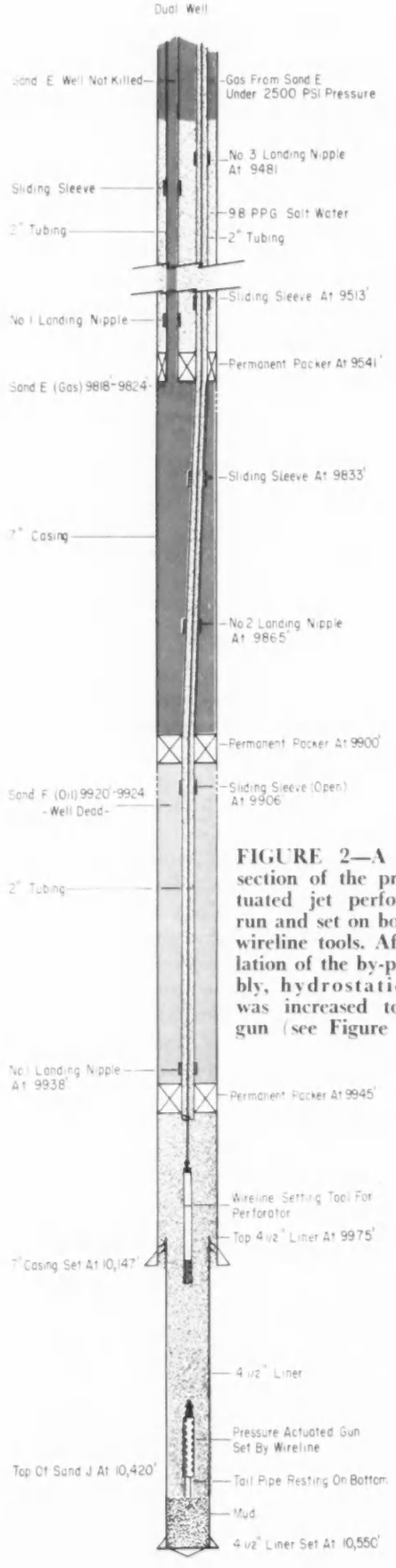
Dual Well
Sand E Well Not Killed
Gas From Sand E Under 2500 PSI Pressure
No 3 Landing Nipple At 9481'
Sliding Sleeve
9.8 PPG Salt Water
2" Tubing
2" Tubing
Sliding Sleeve At 9513'
No 1 Landing Nipple
Permanent Packer At 9541'
Sand E (Gas) 9818'-9824'
Sliding Sleeve At 9833'
7" Casing
No 2 Landing Nipple At 9865'
Permanent Packer At 9900'
Sand F (Oil) 9920'-9924'
-Well Dead-
Sliding Sleeve (Open) At 9906'
2" Tubing
No 1 Landing Nipple At 9938'
Permanent Packer At 9945'
Wireline Setting Tool For Perforator
Top 4 1/2" Liner At 9975'
7" Casing Set At 10,147'
4 1/2" Liner
Pressure Actuated Gun Set By Wireline
Top Of Sand J At 10,420'
Tail Pipe Resting On Bottom
Mud
4 1/2" Liner Set At 10,550'

FIGURE 2—A ten-foot section of the pressure actuated jet perforator was run and set on bottom with wireline tools. After installation of the by-pass assembly, hydrostatic pressure was increased to fire the gun (see Figure 3).

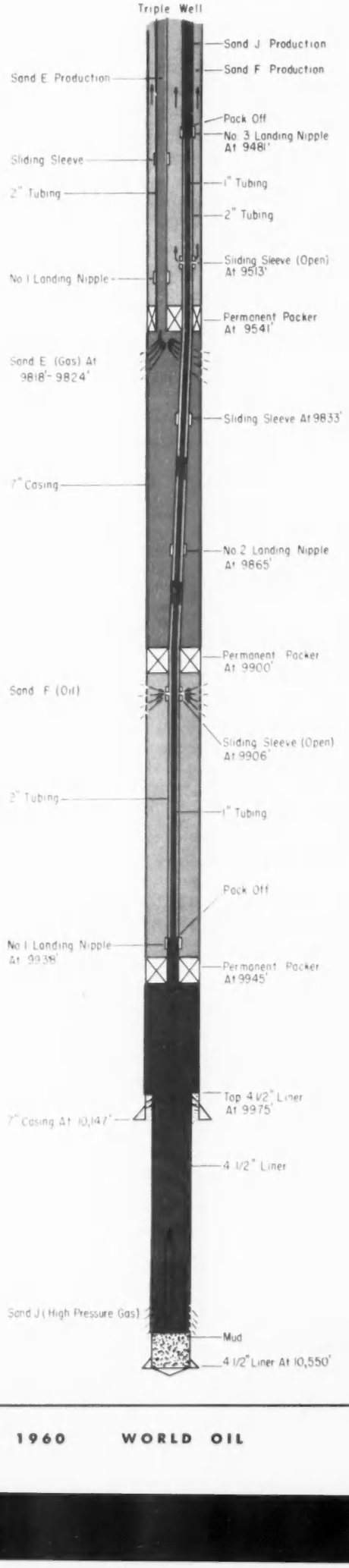

FIGURE 3—Here is a flow diagram for the final triple completion. Note that the gun remains in the hole after firing.

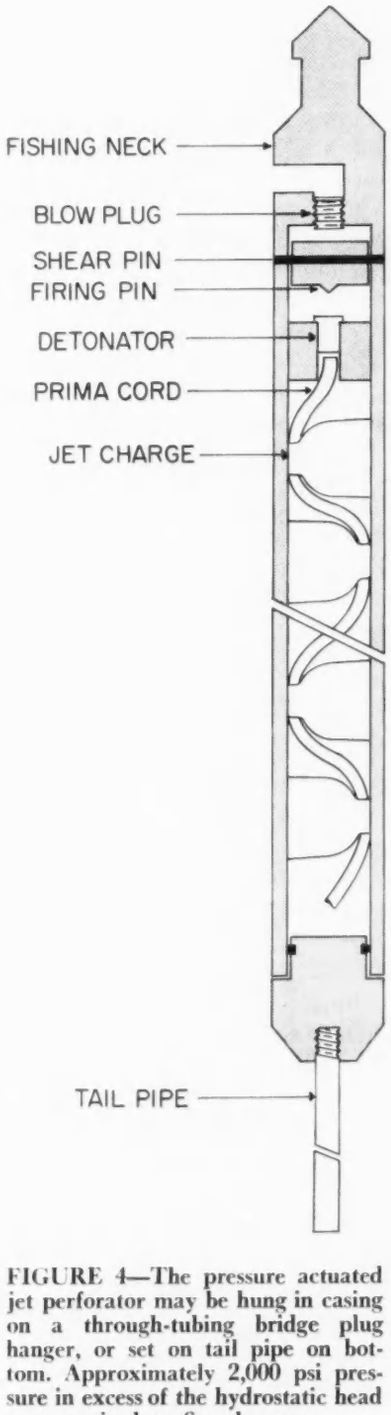

FIGURE 4—The pressure actuated jet perforator may be hung in casing on a through-tubing bridge plug hanger, or set on tail pipe on bottom. Approximately 2,000 psi pressure in excess of the hydrostatic head was required to fire the gun.

in this job was designed to shear at 2,000 psi pressure in excess of the hydrostatic head in the well. When this pressure is attained, the blow plug ruptures, allowing full pressure to act against the firing pin or piston. Pressure then causes the piston to shear the retaining pin, and slam the firing pin into the detonator. This, in turn, ignites the prima cord and detonates the charges.

All debris is contained in the steel gun tube and can be left in the well or retrieved by wireline at a future date.

Procedure. Sand F was killed by breaking down the formation with 20 barrels of dead oil and displacing with 40 barrels of 9.8 ppg salt water. A blanking plug was set in the No. 2 landing nipple of the long string, and the circulating sleeve at 9,513 feet was opened. An attempt then was made to circulate mud from the casing annulus; however, circulation could not be established with 7,000 psi pump pressure.

Although the mud had set up, it was felt that continuous application of pressure on the long string would cause the salt water to channel through the mud and permit circulation. Thus, a high pressure chemical pump was installed, and 4,500 psi pressure was maintained on the column of salt water in the long string for approximately nine days.

At that time, salt water channeled through the mud and the annulus was circulated clean with a pump truck.

The blanking plug was removed from the long string No. 2 landing nipple, and wireline tools were run to check bottom. A "high" bottom was indicated, and it was assumed that rathole mud had also set up. A 1¼-inch OD tubing bailer was used to remove mud from the 4½-inch liner to a point below the interval to be perforated.

The short string of tubing (Sand E gas production) then was tied into the casing annulus on the surface, and gas was used to displace salt water down the annulus, through the long string circulating sleeve at 9,513 feet and up the long string to the surface. Water was displaced until casing pressure remained static at 2,500 psi. The casing then was shut-in.

This procedure was used to reduce the hydrostatic head of fluid on Sand F during completion. That is, release of the 2,500 psi gas pressure would leave a considerably reduced liquid head acting on Sand F, and annulus flow would be induced with little difficulty. Also, this would permit testing the pack-off assembly for a proper seal.

The 10-foot, pressure actuated jet perforating gun with tail pipe was made up on wireline, run through the long tubing string and positioned opposite Sand J (10,423-33). Wireline tools were released and pulled from the hole, leaving the gun in place (see Figure 2).

Approximately 457 feet of 1.315-inch OD special joint tubing with pack-off elements on each end was installed in the long tubing string. The lowermost pack-off was seated in the No. 1 landing nipple at 9,938 feet and the upper pack-off was latched into the No. 3 landing nipple at 9,481 feet (Figure 3).

At this point, approximately 1,000 psi pressure was bled from the casing annulus to check the seal of the pack-off assembly. A static fluid level in the long string indicated a proper seal. It should be noted that this was the only method available to check the seal of the pack-off elements. Had the long string been pressured, the increased hydrostatic head might have caused the perforator to fire prematurely.

The casing annulus then was opened, and Sand F commenced flowing without difficulty. The well was cleaned and turned to the tanks.

Perforating. As indicated in Figure 3, any high pressures resulting from Sand J will be confined to the long tubing string and by-pass assembly. Thus, the well was ready to be perforated.

The short tubing string (Sand E gas production) was connected to the long string on the surface, and a recording pressure gage was installed to obtain a permanent record of pressure surges. Pressure from the Sand E well was applied slowly to the long string, and increased to 2,000 psi. At that pressure, the gun fired as indicated by a pressure surge. The well was unloaded and completed successfully as a gas producer.

Conclusions. Many operators can reduce costs and increase income by applying prudent engineering practices to production operations. As indicated in this article, Hunt was able to utilize a single well bore to maximum extent at minimum cost through application of a new tool, designed especially for the job.

It is felt that closer cooperation between producer, contractor and service company can further reduce operating costs, and prevent the drilling of unnecessary wells.

ACKNOWLEDGMENT

The authors wish to acknowledge the significant contribution of Hunt's district superintendent, H. Mallory, whose cooperation and effort made possible the successful completion of the workover job described in this article.

About the Authors

Gordon S. Rohe received a B.S. degree in petroleum engineering from The University of Texas in 1948. He then was employed by The California Company in Louisiana, and worked in both offshore and onshore drilling and production engineering jobs until 1951 when he was recalled to Marine Corps duty. Following discharge from the Marines in 1952, he joined Hunt Oil Company at Rockport, Texas, as a petroleum engineer. In 1954, he was transferred to Hunt's main office in Dallas as a petroleum engineer, his present position.

Weldon L. Porter is chief well completions service engineer for Welex, Inc., Fort Worth, Texas. He joined Welex in 1954 in sales and was recently promoted to his present position. After graduating from The University of Texas with a B.S. degree in petroleum engineering in 1940, he joined Woodley Petroleum Company of Houston. Following service in the U. S. Navy during World War II, he spent five years as engineer and manager of the oil interest for the Pierce Estate, Wharton County, Texas. In 1951, he joined the Hunt Oil Company interest in Dallas as an engineer. He has been active in AIME work, and is past chairman of the Dallas section of the Society of Petroleum Engineers.

Deep Wilcox, Frio and Edwards spur Upper Gulf Coast activity

Wilcox is now second to Frio in exploration emphasis in northern coastal region of Texas

By Henry S. McQueen
Geological Consultant, Houston

THE UPPER GULF COAST area of Texas (Railroad Commission District 3) has been marked by several significant deep, downdip discoveries during the past year. Important new developments range through the geologic column from the lower Cretaceous Edwards limestone upward thru Eocene (lower and upper Wilcox and Yegua) and Oligocene (Vicksburg and lower Frio).

In exploration thinking and activity, *the search for gas* continues to be emphasized. No abatement of this effort is foreseen.

Two record-setting deep wells were completed in the upper Texas Gulf Coast area in 1960. The Pure Oil Company Houston Farms 1, Galveston County (F 1 on map) reached a total depth of 17,057 feet and was initially completed as a record depth of 16,132 to 16,264 feet. Absolute open flow (AOF) was reported as 7.9 MMcf daily plus 51.1° API gravity condensate with a gas-liquid ratio (GLR) of 60,000:1. Shut-in pressures were 9,300 psi on tubing and 13,800 psi bottom hole. As this article was prepared, it was announced that salt water had encroached in the productive sand and the well has been abandoned.

The other record deep test is Shell Oil Co. Carroll 1 in the Brushy Creek area of DeWitt County [E-1—W-2 on map (and No. 9 on south Texas map)] in Railroad Commission District 2. This well, at total depth 19,765 feet, is the deepest well yet drilled in the Texas Gulf Coast.

Important exploration events for the past year are briefly described below.

Edwards limestone trend. Discovery of commercial production in the Edwards formation in Persons field, Karnes County, has resulted in great interest in deep Edwards possibilities in Railroad Commission District 3 as well as in south Texas.

The greatest impetus to Edwards exploration in the area of this report was given by Mobil Oil Sylvia W. Kahanek 1, located in Word field about six miles southwest of Hallettsville, Lavaca County. Previous production has been from Wilcox sands. This test was drilled to 14,361 feet. Mechanical trouble (collapsed casing) beset this operation. After considerable remedial work the well was completed in eight zones in the Edwards in the interval 13,320 to 14,278 feet. Seven-inch casing was set at 14,360 feet. Completion data reported by Mobil are as follows: calculated open flow 3,600 Mcf daily plus 14.2 barrels of 52.2° API gravity condensate per MMcf; TP (adj. ch.) 3,374 psi; SITP 3,822 psi; BHPSI 5,427 psi. Mobil announced the staking of a confirmation test in September.

Two other Edwards tests southwest of District 3 are Shell Carroll 1 in the Brushy Creek field (previously mentioned), and Texas Eastern Transmission Co. Garbe 1, located three miles west of Nordheim. Both tests are in DeWitt County. The Shell well bottomed at 19,765 feet in the Edwards limestone where strong water flows were reported. Discovery of gas was in the Wilcox. The Texas Eastern well was reported in the Edwards limestone in September at 14,192 feet. A drill stem test of the interval 13,961 to 14,039 feet resulted in recovery of 270 feet of gas-cut mud and 180 feet of gas-cut salt water plus 6,000 feet of water cushion, according to reports. Considerable information on Edwards possibilities is anticipated from this test. The interval 14,042-14,192 feet was reported cored.

Lee County Edwards test. Another deep test that will yield information on the Edwards and probably on older formations too is Union Producing Company No. 1 Preuss, located 1¼ miles south of Giddings. This rank wildcat, some 20 miles south of the nearest production, was reported to have obtained 45 feet of condensate and 225 feet of distillate-cut mud in a drill stem test of the interval 10,802-10,818 feet. Total depth is said to be 12,246 feet.

Other Edwards tests. A rank wildcat being drilled in September and being followed with great interest is in Walker County. Standard Oil Company of Texas Doyle F. McAdams 1 located 13 miles northwest

Edwards Developments

E-1 W-2 Shell Carroll 1
E-2 Persons Field
E-3 Mobil Kahanek 1
E-4 Texas Eastern Transmission Co. Garbe 1
E-5 Union Prod. Co. Preuss 1
E-6 Standard Oil Co. of Texas McAdams 1
E-7 Davidson Neyland 1
E-8 Potter Schroeder 1

Wilcox Developments

W-1 Standard Oil Co. of Texas Lenoir M. Josey, Inc. 1
W-2 E-1 Shell Oil Co., Carroll 1
W-3 Humble Oil & Refining Co. White 1
W-4 Commonwealth et al Wuensch 1
W-5 Quicksand Creek
W-6 Pure Binz 1

Yegua Developments

Y-1 Shell Oil Co. Bill Daniel 1
Y-2 Sinclair Vickers Fee 6

Vicksburg Developments

V-1 Texaco Park Place 1
V-2 Hunt-Herbert Ward 1
V-3 Shell Herbert-Broussard 1

Frio Developments

F-1 Pure Oil Co., Houston Farms 1
F-2 Humble, Williamson 1
F-3 Gulf Oil Corp., Phillips 1
F-4 Sun Oil Co., Houston Farms 1
F-5 Meredith, Mixson 1
F-6 Gulf Oil Corp., Miller-Vidor 3
F-7 Humble, Phelan 9
F-8 Superior Oil Co., Maude B. Traylor 1-B
F-9 Humble, Lewis 1

Note: Shell Carroll 1, DeWitt County (W-2—E-1 on map) found gas-condensate in the Wilcox but was not productive in the Edwards limestone.

Important deep Frio, Wilcox, Edwards plays extend from Lavaca, Jackson counties into District 3. Yegua and Wilcox trends overlap.

of Huntsville, was approaching the projected total depth of 11,500 feet.

Another well of interest being drilled was H. A. Potter, et al Schroeder 1 on the flank of Clay Creek Dome, Washington County. Projected depth was 14,000 feet.

A wildcat Edwards test was also recently announced by Davidson and Davidson who will drill Herbert Neyland 1 to 12,000 feet. Location is in northwestern Tyler County, eight miles northeast of Colmesneil. The nearest Edwards production was in the abandoned Glendale field, Trinity County, some 40 miles to the west.

Edwards exploration may be expected in the coming years on large, well-defined structural features beneath presently developed younger and shallower reservoirs. Exploration geologists are mindful of reef and related possibilities in this formation.

Wilcox formation. The past year has seen some notable developments of production from the Wilcox group. There has also been a vigorous revival of interest and an entirely new concept with regard to the possibilities. The Wilcox is now probably second (to the Frio) in exploration emphasis and activity in the Gulf Coast, having replaced the Yegua in this category.

Although the Wilcox group has been productive from several fields in District 3 for many years, it has been more or less spasmodically explored.

Developments in south Texas have stimulated interest. The successful completion of upper and lower Wilcox wells in DeWitt and Lavaca Counties near the southwest end, and also in Newton and Jasper Counties in the northeast end of District 3 have caused this trend to undergo its current activity.

An outstanding downdip Wilcox discovery has been obtained at Standard of Texas Lenoir M. Josey, Inc. 1, located 3½ miles from Cypress in Harris County. Top of the Wilcox was reported to be 9,930 feet. This well represents the first Wilcox production in this county. Nearest updip Wilcox production is at Lake Creek and Pinehurst in Montgomery County, some 18 to 20 miles distant. Thin upper Wilcox sands have been drilled previously in the Hockley dome and Katy fields, and a deep test drilled in the Tomball field some ten miles distant found a considerable thickness of well-developed Wilcox sands and shales. As a result of this discovery leasing activity along the Wilcox trend from Lavaca County on the southwest to Montgomery County on the northeast has been accelerated. Increased seismic activity is also reported.

Completion details for the Josey Ranch well are reported as follows. Lower tubing perforations from 11,350 to 11,370 feet yielded an AOF of 14,200 Mcf daily plus 45.2° API gravity condensate, GLR 40,600-1; BHSIP 8,409 psi, SITP 6,860 psi. Upper tubing perforations at 11,130-11,140 feet gave an AOF of 3.55 MMcf daily, plus 47° API gravity condensate, GLR 56,200:1, TP 6,635 psi, BHP 8199 psi. Total depth was 13,045 feet. The field has been designated as Cypress Southwest.

Regarding downdip development of Wilcox sands, a dry hole was completed in September at Pure Oil Company N. A. Binz 1, some 2½ miles southwest of Fulshear field, Fort Bend County. This well was reported to have had shows. It was abandoned at 13,525 feet. Details, when available will be helpful in further evaluating the possibilities of the deep, downdip Wilcox.

The very important lower Wilcox discovery in DeWitt County, Shell Carroll 1, was perforated from 11,187 to 11,203 feet. Calculated AOF was 4.63 MMcfd plus 31 barrels of condensate daily. Pressures were reported as follows: Surface, 4,725; BHPF, 5,895; and BHPSI 8,525 psi.

Lower Wilcox production in DeWitt County was also obtained by Humble Oil & Refining Co., Albert P. White 1, located 6 miles southwest of Cuero. From perforations 10,120 to 10,140 feet this test flowed 874,000 cubic feet daily plus 23 barrels of 54° API gravity condensate per million. Reported shut-in pressures were: tubing, 3,230 psi; bottom hole, 4,526 psi.

A new middle Wilcox discovery has been made by Commonwealth Oil Co., Harkins and Company and Humble. The completion of the No. 1 Hugo Wuensch from perforations 10,388-10,408 not only represents a new zone discovery but also the deepest production to date and an extension of about one-half mile in the Yorktown field area, four miles to the northwest of the town of that name. Potential was reported as 10 MMcf daily, GLR 14,850:1, gravity 50.3° API, SITP 4,490 psi.

Newton-Jasper Wilcox play. Significant upper and lower Wilcox discoveries have also been made in Newton and Jasper counties in the easternmost portion of the subject area. Most notable of several new Wilcox fields is Quicksand Creek, Newton County, found by Oil Reserves Corporation. This field now has ten producing wells with productive sands ranging in depth from 9,800 to 11,300 feet. This anticlinal structure has recently had an important eastward extension. Oil Reserves Corp. Pearl D. Peters 1 potentialled 6.7 MMcf daily plus 51.1° API gravity condensate; GLR was 12,300:1. The discovery and rapid development of the Quicksand Creek field has greatly increased interest in Wilcox exploration in the northeastern part of the area.

Other recent discoveries from upper and lower Wilcox sands are Hickory and East Hickory Creek, Hardin County; Theuvenens Creek, Tyler County; East Call, Jasper County; Bleakwood, Newton County, and Longs Station, Hardin County. With lower Wilcox production established near the extreme southwest portion and also in the extreme northeast portion of District 3, and with the important downdip discovery in Harris County, intensive exploration for additional reserves in this group is expected during the next several years.

Yegua. Interest in the Yegua has been maintained throughout the past year. Several new discoveries and extensions of older fields have been made along this trend, particularly in the eastern portion of the area.

An important downdip discovery was made by Shell Bill Daniel 1, located 2 miles southeast of Raywood field in Liberty County. The discovery, made in July 1959 but not announced till later, is called Rich Ranch field. Production data on the discovery well are as follows: TD 13,970 feet, PB 11,218 feet; 5½-inch casing set at 11,345 feet; perforated 11,105-127 and 11,085-089; TP 5,900 psi; GOR 2,544-1. This field was confirmed by the Bill Daniel 2 well. Subsequently two dry holes have been drilled and a fifth test was drilling in September.

An interesting discovery in three pay zones in the updip Yegua trend is Sinclair Oil and Gas Co. et al J. A. Vickers 6, located 3 miles northwest of Silsbee in Hardin County. This well was drilled to 11,075 feet. Nearest production is some 9,000 feet northwest in Vickers-Ada (Wilcox) field. The three productive Yegua zones are in the intervals 6,681-86 feet (gas condensate); 6,941-48 feet (oil); and 7,342-48 feet (gas condensate). The well was a failure in the Wilcox.

Another Yegua development is the recent discovery by Atlantic Refining Co. in the Skinners Lake field, Newton County, where Suddeth 5 flowed 193 bopd, gravity 49.9° API. Production was through perforations 7,708-13 feet.

In the northeastern and central portions of this area, recent developments have caused Yegua and Wilcox production belts to overlap. Consequently additional exploration targets are presented.

Vicksburg. Interest in downdip Vicksburg sands has been heightened by the presence of deep sand in several wells, particularly in the southeastern portion of the area. Among them is Texaco, Inc. Park Place 1, Port Arthur field, Orange County, which was drilled to a total depth of 14,050 feet. Through perforations

13,990-995 feet this well flowed an unreported amount of gas with 6,000 psi tubing pressure (flowing) and 9,000 psi shut in.

Subsequent drilling in the Port Acres and Port Arthur fields of Jefferson County has revealed that deep Vicksburg sand, being erratically developed, is absent in some wells. Although the author has not attempted a study of this problem, it appears that the deep sand is lenticular in nature and the lenses are of no great extent. This view is supported by the disappointing production characteristics of those wells where the deep sand has been found.

Vicksburg production in Port Acres field was first found in Meredith Dornboos 6. This well is reported to be a good producer, although certain later Vicksburg completions are said to be less productive.

Regarding Vicksburg sand development, a dry hole, Lyda Hunt-Herbert Trusts C. E. Ward 1, located 1½ miles northeast of South Taylors Bayou field and 5 miles west of Port Arthur, Jefferson County, yielded some interesting data. More than 200 feet of Vicksburg sand was found in this well. Although it was abandoned as dry at 12,869 feet, the Vicksburg possibilities on structure in this locality are enhanced.

Another significant deep test was drilled by Shell Herbert-Broussard "B" 1 (Herbert Ranch), 4 miles southwest of Port Acres in Jefferson County. This well was reported as a dry hole at 15,457 feet.

Exploration for deep Vicksburg sand production in portions of Chambers, Jefferson and Orange Counties may be expected, complementing attempts to find production in the deeper downdip Frio sands.

Frio. This summary will present only a few highlights of recent Frio trend exploration activities. There has been no lessening of interest in searching for production in the Hackberry, Nodosaria, Textularia mississippiensis and Anomalina bilateralis sections of this complex formation.

There is much current leasing activity in these trends, and several deep wells have been recently completed or are in progress. These will add greatly to the knowledge of the complex stratigraphic problems, the matter of sand development and extent, and the productive characteristics of this formation. Intensive exploration and development of production of the Frio sands continues in Matagorda County which is the subject of another article in this edition of World Oil.

A few of the wells of greatest interest are as follows:

- The Pure Oil Company Houston Farm Development Co. 1, Galveston County (previously described).

- A significant Frio discovery apparently was made by Humble A. B. Williamson 1, located 3½ miles south of Angleton, Brazoria County. This well was perforated from 12,166 to 12,172 feet. Calculated open flow was reported as 142 MMcf daily, GOR 119,000:1, gravity 44.2° API, SITP 6,845 psi. This discovery is located on the southeast flank of the Collins Lake field and is separated from it by several dry holes. The new producing sand (not present in Collins Lake field) is thought to be located in the lower part of the Frio section. The confirmation well, Humble Angleton Gas Unit 1 was completed at a total depth of 12,400 feet through perforations 12,124-134 feet. Potential was 238 MMcf daily, TP 6,600 psi, GLR 80,000:1

- Gulf Oil Corp. Phillips 1, located 2 miles west of Sargent, Matagorda County, was drilled to 16,646 feet (total depth). Full data from this well, when released, should throw much light on deep, downdip Frio sand development

- Sun Oil Company Houston Farms Development Co. 1, located 2 miles northwest of Alligator Point, Brazoria County was drilled to 18,012 feet and was reportedly completed as a gas well through perforations 15,986-15,995 feet

- Midwest Oil Co. Houston Farms Development Co. 1, located in Brazoria County 10 miles south of Alta Loma bottomed at 16,057 feet and is also pertinent to appraisal of downdip, deep Frio possibilities, although the well was dry

- A Hackberry trend discovery was made by Meredith and Co. Mixson Land 1 four miles northwest of Fannett, Jefferson County. A daily flow of 215 barrels of 35.5° API gravity oil was reported from perforations 8,230-34 feet. The Gilbert Ranch field to the east is the nearest production

- Gulf made a small oil discovery of significance to deep Frio exploration at Miller-Vidor Land Co. 1, located in Orange County 2½ miles north of Vidor. Nearest production is one mile to the north at Vidor field. Completion was for 26 bpd on 6/64-inch choke, TP 1,450 psi, GOR 8,870, gravity 44° API. Total depth was 14243 feet

- Opening of new Frio sand production in Amelia field, Jefferson County, recently created strong interest. Humble J. H. Phelan 9, a well drilled in 1937 to 6,775 feet was worked over and deepened. It flowed 223 barrels of 38.7° API gravity pipeline oil daily from perforations 7,349-52 in the Hackberry zone. Reported GOR was 798:1 and casing pressure, 1,220 psi.

The discovery well of the Rugely field, Matagorda County, was Humble First City National Bank of Houston 1, located 12 miles southeast of Bay City and about 2 miles south of the Old Ocean field. Perforated from 13,034-068 feet, this test was reported to have an absolute open flow of 2,650,000 cubic feet daily plus 48.3° API gravity condensate. GLR is 14,000:1. Shut in tubing pressures was 8,355 psi. This discovery prompted an active leasing play.

Frio sands have also been found productive in the San Antonio Bay area of Calhoun County where wells have been completed by Tidewater Oil Co. and Brazos Oil and Gas Co.

A recently-announced test that will be followed closely by those interested in deep, downdip Frio sand prospects is Superior Oil Co. Maude B. Traylor 1-B, permitted to 16,000 feet. This well is located in the Point Comfort area of Calhoun County. Recently Tennessee Oil and Gas Co. found production in this locality at 10,630-45 feet and at 13,050 feet, and

Continued on Page 126

How lower Frio changes in depth

By A. H. Wadsworth, Jr.
Consulting Geologist, Houston

A NEW CONCEPT in Gulf Coast structural geology has been unfolding in recent years in the Frio trend in Calhoun, Jackson and Matagorda counties. Although these conditions are seen in other areas and trends, they are probably nowhere more dramatically illustrated than in some of the fields now being developed in these counties.

In the early days, the Gulf Coast Basin was envisioned as a quiet sedimentary basin in which marine shales and sands were deposited in alternation with non-marine beds. It was thought that there was little tectonic activity save around the numerous salt masses that had intruded the beds during and after deposition. These salt intrusions caused sharp folding and complex faulting in their immediate vicinities. But in the absence of salt intrusion, it was thought that the beds were too incompetent to shear and that they would be gently folded and warped over the deep-seated domes. This concept, on the whole, was an accurate one—to the depth to which they were drilling in those days.

New information supplied by many deeper penetrations in the Frio trend shows that this is only part of the picture. Accurate as it might have been for the Miocene and upper Frio beds, this concept is inadequate to explain the many complexities found in the lower Frio section.

Big structures at depth. Whereas the upper Frio and Miocene beds were laid down in relative quiescence, lower Frio deposition was effected by diastrophic forces not unlike mountain building in intensity. Although evidence for compressional forces usually associated with orogenic belts is totally lacking in the Gulf Coast, nevertheless the existing forces created spectacular structural and stratigraphic conditions.

Recent deep drilling has forced geologists to adopt a new approach to mapping the lower Frio. The "typical" Gulf Coast structure with anticlinal closure on the downthrown side of a fault is found to be not so typical of the lower Frio beds. *Mapping based on this premise is only partially correct.*

New discoveries at El Maton, Pheasant and Palacios fields in Matagorda County, and in the Maude Traylor—Green Lake trend in Calhoun County, have changed many old ideas. The structural configuration at 8,500 feet is not the same as that found at 10,500 feet and that of the latter depth may not be the same at 12,000 feet. It is no longer prudent to map only at a shallower horizon, where there may be a maximum of control, and assume that the same configuration can be projected into deeper beds. This is the mistake that many geophysical interpreters make

This article shows the geologic setting of prolific new gas-condensate production being found in Matagorda, Jackson and Calhoun counties, Texas. Some of these deep lower Frio structures have more than 1,000 feet of closure. They are masked by gently south-dipping upper Frio sediments. Development of this play was delayed not only by greater drilling depths but also by the tendency on the part of both geologists and seismologists to project the shallow structure into the deep beds in their interpretations.

There seems to be no reason why similar conditions cannot exist throughout the Frio, Yegua, and Wilcox trends southward into Mexico. Northeast limits of this type of geology are not known either. Hence, this article is believed to be of great significance to the deep gas-condensate possibilities of the Texas Gulf Coast. The lower Frio play is yet another example of deep drilling primarily for gas.

and is the reason that some of the above named discoveries did not "shoot out."

Deep, north-tilted fault blocks. Much of the lower Frio trend is made up of arcuate fault blocks tilted to the north with steep south faces. Structural relief is often *more than 1,000 feet*. One is reminded of the great tilted fault blocks in the Basin and Range Province, but the Gulf Coast blocks have little in common with those. The origin of these steep south faces is intriguing and is due to a combination of actions:

- Fault displacement, probably due to slumping of arcuate segments of the Continental Shelf into the Gulf Coast geosyncline
- Local movement of diapiric shale and/or salt
- Submarine erosion
- Multiple stages of tilting due to the action and counteraction of forces.

These actions were being accomplished simultaneously with sedimentation. Each action had an effect on the others and they all profoundly affected sedimentation. Wells drilled as little as a mile apart cannot be correlated in the lower Frio because the beds penetrated were laid down in different blocks under differing environments. On the other hand, sections along strike in the same block can be correlated very well.

Fault blocks buried, masked. Characteristically, these blocks of north-tilted lower Frio beds become buried under middle and upper Frio sediments that mask any semblance of north dip. However, *isopach maps of carefully-selected intervals may suggest their presence*.

Dip closure is formed at the south extremity of the block where the beds drape over or become down-faulted. Lateral closure is usually of much less magnitude than is north or south closure, with the result that the fields are often elongated and *production may extend across saddles into other closures*.

Figure 1 is a cross-section of one of these blocks. Notice that the north dip, so obvious on the lower Frio beds, is buried and obliterated under younger deposition. Mapping on the top of the Frio, or even 1,000 feet into the Frio, would not disclose an anomoly. Geophysicists must learn to recognize this downdip convergence of beds in their records before they can map this type of feature. Geologists must learn to appreciate the significance of *downdip thinning* of deep beds.

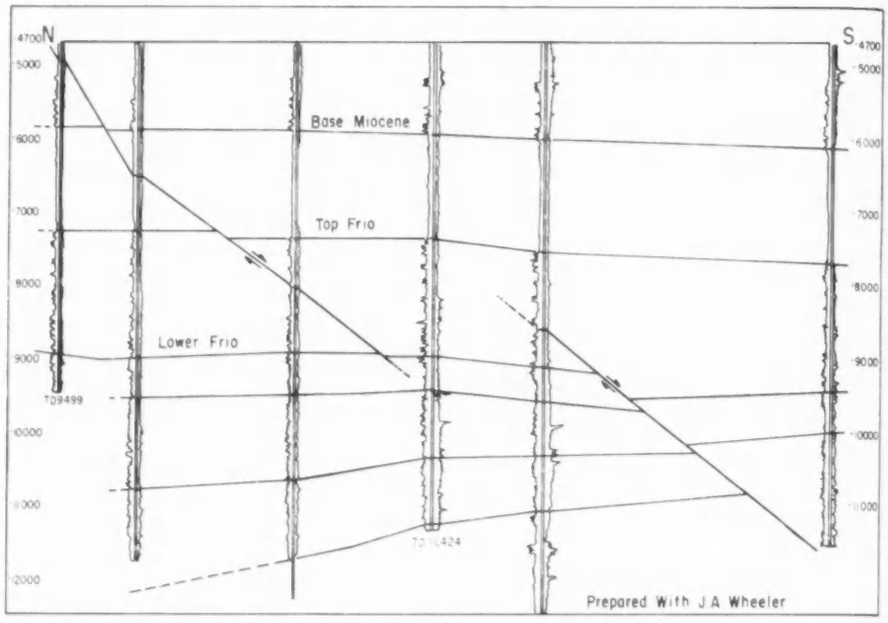

FIGURE 1—This cross-section of electric logs of six wells on a line from north (left) to south (right) shows regional south dip on Miocene and upper Frio beds, and pronounced north dip in the deeper Frio beds. Fault plane at right, dying out in the shallower horizons, is a further indication of buried deep Frio structure. Rich gas-condensate finds are being made in lower (below Text. miss.) Frio sands in Matagorda, Calhoun, and Jackson counties. El Maton and Pheasant fields in Matagorda typify such upthrown depositional-type fault trap fields. There appears to be no reason why similar deep structure might not extend throughout Coastal Texas southward to Mexico, nor are northeast limits of similar possibilities known.

Structure shifts with depth. This type of feature causes "intermediate" structures. In this example, the upper Frio dips southerly across the anomoly. At about the top of the lower Frio the effect of deep uplift becomes felt and the beds are flattened. Below this point, they begin to dip northerly and closure is effected. Closure migrates with depth into the core of the uplift so that the axis of closure will shift downdip toward the steep south face of the block. Thus the productive area of a given sand will shift as the axis of closure on that sand shifts.

South dip crucial for deep production. For years north or reverse dip has been sought in the Gulf Coast as the critical dip to control production. In working with this type of deep Frio feature, the point where south dip prevails must be found. That is the critical closure because within a given block, north dip is the "normal" dip for exploration purposes.

Gravity slumpage has played an important part as a triggering mechanism to create the tilted blocks. As sediments piled up on the floor of the Continental Shelf at a rate of deposition faster than the rate of general subsidence, the angle of repose of the sediments exceeded that of the inclination of the depositional base, and slumpage occurred. Bornhauser[1] has described this process in detail and has reported on an actual example that he has called the Hartburg Flexure.[2]

Slumpage caused imbalance and new forces were introduced to restore balance. It is beyond the scope of this article to discuss the structural genesis of these blocks, but a few observations relative thereto are pertinent.

1. Slumpage created an unequal distribution in the mass of the Continental Shelf. This in turn caused differentials in the weight of overburden on buried shale and salt beds, both capable of plastic flow.

2. Salt and/or shale began to flow through buoyancy upward at points adjacent to the greatest pressure differential.

3. Diapiric salt and shale uplifted

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About the Author

A. H. Wadsworth, Jr., is a consulting geologist and independent oil operator in Houston. He received his BS and MA degrees in geology from the University of Texas and has worked for Seaboard Oil Company, Texaco Inc., and the United States Geological Survey. A consultant in Bay City, Texas, he moved his offices to Houston in 1956.

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and intruded overlying beds and in many places penetrated the sea floor.

4. These intrusions were local in extent. They profoundly affected deposition and made regional correlation difficult if not impossible.

The finding of prolific, deep Frio closures below structureless upper Frio horizons illustrates the need for flexible geological and geophysical thinking and interpretation. Both subsurface geologists and seismic mappers have heretofore projected and extrapolated shallow regional structure into their interpretations of lower Frio structure. Furthermore, geologists have been too prone to accept fully such seismic interpretations of deep Frio structure.

Of course, the seismic technique remains a principal exploratory tool. However, its effectiveness is greatly reduced in a totally new province with no prior knowledge of the geological setting. To a degree, this situation has occurred in the lower Frio trend. This trend was not only new, but it was further retarded by preconceived ideas as to how the structure should be mapped.

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Upper Gulf Coast

Continued from Page 122

thereby considerably extended the area of interest.

A recent Matagorda County discovery of importance was made by Humble Lewis 1 at Duncan slough near Buckeye field. The well bottomed at 11,709 feet and flowed 558 barrels daily of 45° API gravity pipeline oil plus 1,340 Mcf of gas daily on a 10/64-inch choke from perforations 10,612-620. The reported GOR was 2,580:1 and tubing pressures were as follows: flowing, 5,150, and shut in, 5,450 psi. From perforations 10,662-70 this well also flowed 1,062 bopd on ¼-inch choke; GOR, 3,880:1; gravity, 46.2° API; TP, 4,400 psi.

From the foregoing it is safe to predict that there will be no lessening of Frio exploration activity for many years. Primary emphasis is on sands in the downdip section in the coastal counties.

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About the Author

Henry S. McQueen is a geological consultant in Houston. A graduate of the University of Missouri, McQueen served as assistant state geologist in Missouri before joining Alcoa Mining Company. During an eight-year period prior to 1951, he directed Alcoa's exploration program for gas reserves for the company's Port Lavaca plant, and supervised development of Alcoa's Magnolia Beach gas-condensate holdings in Calhoun County and the Moody Ranch-Carancahua Bay area in Jackson County. On January 1, 1951, he became chief geologist and executive vice president of Salt Dome Production Company in Houston. He resigned from Salt Dome recently to enter consulting practice.

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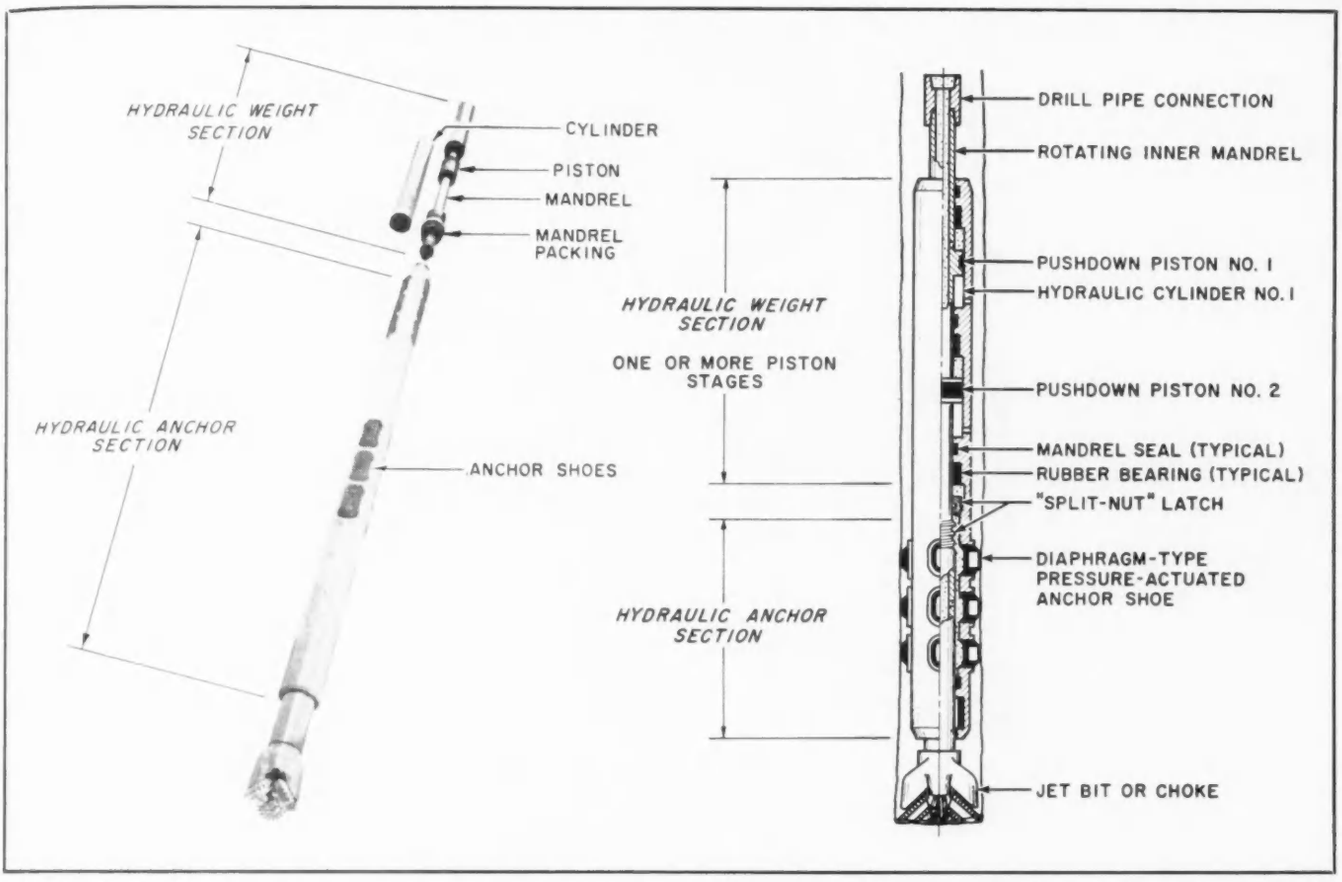

FIGURE 1—Hydraulic wall-anchored drill collar broken into the hydraulic anchor section and the hydraulic weight section.

FIGURE 2—This schematic diagram shows the hydraulic wall-anchored drill collar and its component parts.

How to increase bit weight for less cost

This new hydraulic wall-anchored drill collar is first tool to provide bit loading without dead weight

By J. M. Kellner, Research Engineer, and
A. P. Roberts, Head, Well Completion and Development Section,
Jersey Production Research Co., Tulsa

THE TREND in modern drilling practices is toward higher bit weights. In conventional practice, high weight is obtained with longer and/or larger diameter drill collar strings. This usually results in longer trip time, increased hoisting power demands, and additional pressure losses in the system. Also, high weight cannot be applied when hard rock is encountered at the surface.

To obtain high bit "weight" near the surface and reduce tripping time at depth, a new lightweight, high output force applicator called the hydraulic wall-anchored drill collar was developed.

The primary advantages of this tool are:

- Surface holes can be drilled more economically where the use of sufficient bit weight is prevented by limitations of drill collar length
- Drill collar handling time is reduced
- Hoisting power requirements are lower or rig depth rating is increased
- Initial investment costs are lower.

It is possible that extensive field testing will determine other important advantages, such as:

- Bit life and/or weight capacity of the bit may be increased due to the hydraulic shock absorbing action of the tool
- Hole deviation may be reduced even though maximum bit weight is employed.

The hydraulic wall-anchored drill collar is the first tool to provide bit loading without the use or aid of dead weight. Shallow drilling tests

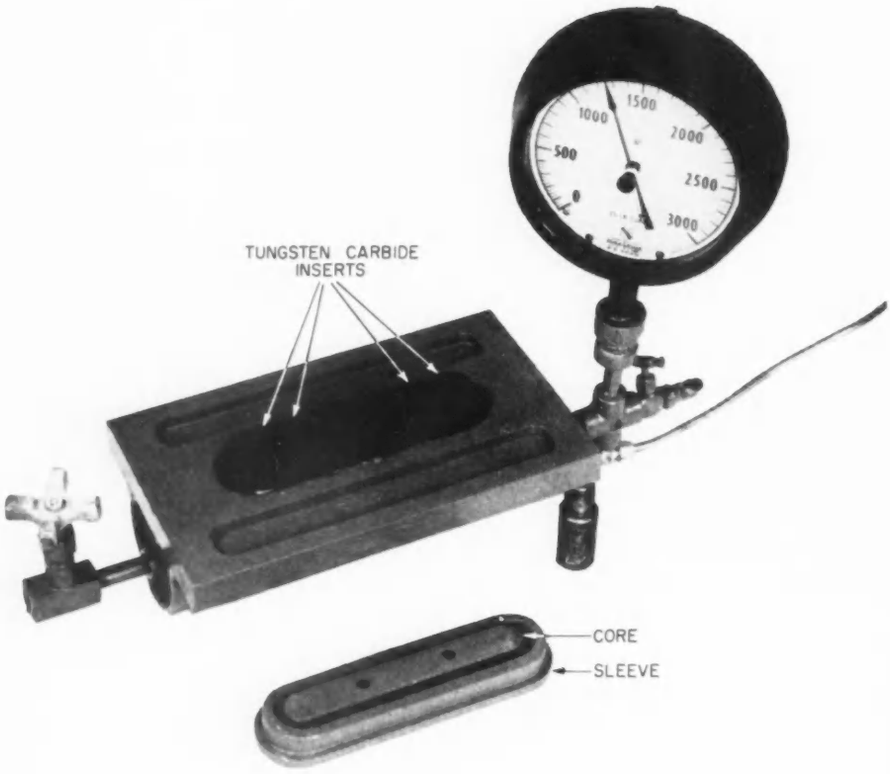

FIGURE 3—The anchor shoe in its expanded position.

indicate that because anchoring high loads to the borehole wall is practical in competent formations, it is possible to eliminate the need for long drill collar strings. The present tool shows considerable promise for reducing drilling cost in hard-rock drilling. In medium formations, its stroke limitation can be overcome by an automatic resetting feature currently being tested.

DESCRIPTION OF TOOL

A prime consideration in the development of the wall-anchored drill collar was the means of applying bit weight. Utilization of pressure drop across the bit to apply the force hydraulically seemed reasonable. By staging hydraulic cylinders in series, the tool could develop the same or higher bit weights than are now used.

The next problem was that of absorbing the up-hole hydraulic reaction. This force had to be contained without use of dead weight, or the purpose of the tool would be defeated. For this reason, it was decided to anchor the tool to the wall of the borehole.

The hydraulic wall-anchored drill collar has two major sections: the pushdown section and the anchor section, plus a retaining latch. A picture of the tool partially disassembled is shown in Figure 1 and a schematic drawing of the tool is shown in Figure 2.

Hydraulic weight section. The pushdown section consists of one or more single-acting hydraulic cylinders staged in series. The bit load or "weight" evolves from the differential pressure on the pistons within the cylinder. Jet bits would normally be used to supply the pressure drop; however, if conventional watercourse bits are desired, a suitable choke can be installed between the tool and the bit.

Each piston is attached to a hollow rotating inner mandrel which, in turn, is attached at its upper end to the drill pipe and at its lower end to the bit. Pressure is supplied to the pistons through a port in the mandrel. The lower side of the piston is vented to the annulus through a port in the cylinder. The pistons and the inner mandrel rotate within the cylinders, which are held stationary. Both the mandrel and the piston are supported by rubber bearings to reduce mandrel deflection, thereby increasing seal life and decreasing mandrel fatigue failures.

Anchor section. To control the upward thrust and center the tool in the hole, the anchor section uses diaphragm-type pistons, called anchor shoes, which are expanded by bit nozzle pressure against the wall of the hole. These anchor shoes are mounted in an anchor sleeve attached to the lower end of the cylinder section. Pressure is supplied to the anchor shoes through a port in the mandrel. Rubber bearings are

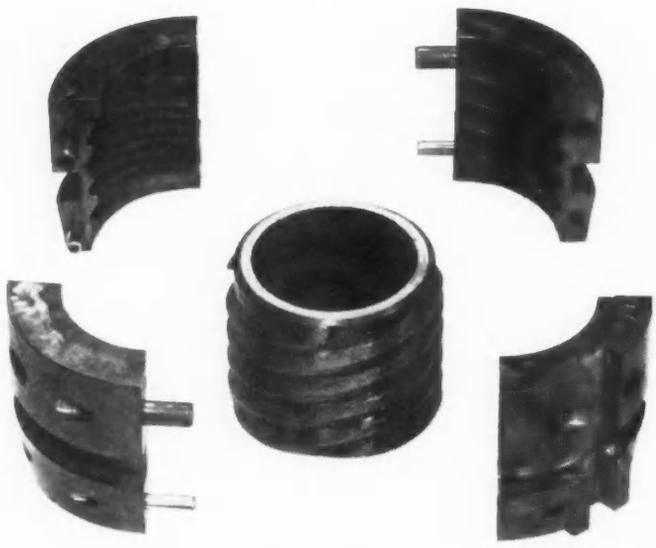

FIGURE 4—This "split nut" retaining latch locks the outer case to the inner mandrel.

also provided in this section to reduce mandrel deflection.

The anchor shoe is shown in Figure 3 in an expanded position. It consists of a metal outer sleeve and a metal inner core, as pictured beside the expanded shoe. Rubber is molded in the slot between the core and the sleeve and bonded to each piece. A heavy rubber lip is bonded to the outer sleeve to seal the shoe in the anchor sleeve. Tungsten carbide cylinders, embedded in the core, provide positive wall grip.

Split-nut latch. In addition to the pushdown and anchor sections, the tool contains a "split-nut" retaining latch (Figure 4). This device locks the outer case, composed of the anchor sleeve and the cylinders to the inner mandrel when the pushdown pistons are in the upper position within their cylinders. A pressure is applied simultaneously to both the pushdown pistons and the anchor shoes, the latch prevents upward movement of the outer case until it is firmly anchored.

The latch is engaged by pulling the male member through the split nut, which is mounted in the anchor sleeve. It is disengaged by rotating the drill string to the right after the tool is anchored.

Sequence of operation

1. The tool is run to bottom, with the mandrel in the upper end of its stroke. In this position the outer case is locked to the mandrel by the latch.
2. Circulation is started to produce sufficient pressure drop (400-700 psi) across the bit to set the anchor shoes.
3. The drill string is turned to the right to unlock the latch. The circulation rate is then increased to apply the desired force to the bit.
4. The drill string then advances as drilling continues for a length of the mandrel stroke (this is governed by the length each piston can travel within its cylinder).
5. At the end of the stroke, rotation of the drill string is stopped, the pressure drop across the bit is reduced to 200-300 psi, and the mandrel is returned to its initial position. At this reduced pressure, the shoes remain anchored while the hoisting pull is reduced. At the top of the mandrel stroke, the latch locks the case to the inner mandrel.
6. The pump pressure is then reduced to zero, the tool is returned to the bottom of the hole, and the sequence is repeated.

To use all of the bit force available, the drill pipe is held at its recorded weight while drilling. This places the neutral point of the drill string at the top of the tool. To use only a portion of the tool's output, the hook load is increased above the weight of the drill string alone. For example, if the tool is exerting 50,000 pounds weight on the bit and it is desired to use only 30,000 pounds, the hook load is increased by 20,000 pounds.

Size and capacity of prototype tool. The prototype tool was designed for 6¾-inch hole. It is 6 inches in diameter, 37 feet long, weighs about 2,200 pounds, and has a 2-foot drilling stroke. It is capable of exerting about 40,000 pounds force at the bit, using a pressure drop across the bit of 1,000 psi. This capacity was obtained by employing three hydraulic cylinders in series, plus a small differential area formed by increasing the mandrel diameter through the anchor section.

The anchor section contains 24 anchor shoes placed at eight levels along the anchor sleeve. Each row contains 3 shoes, 120 degrees apart. They are contained in the sleeve so that the initial shoe extension to gage is ⅛ inch. Additional extension is available to compensate for hole enlargement.

STATUS OF DEVELOPMENT

Initial tests were aimed at determining the anchoring capacity of the tool at shallow depths. Further work was concerned with the development of high-pressure anchor shoes and testing of the tool in shallow drilling at jet bit pressures.

Anchor tests. Initial anchor tests showed that both high thrust and torsional loads could be anchored in an open hole. The effect of both water and high-viscosity muds was tested. Increased mud viscosity caused no appreciable increase of anchor slippage.

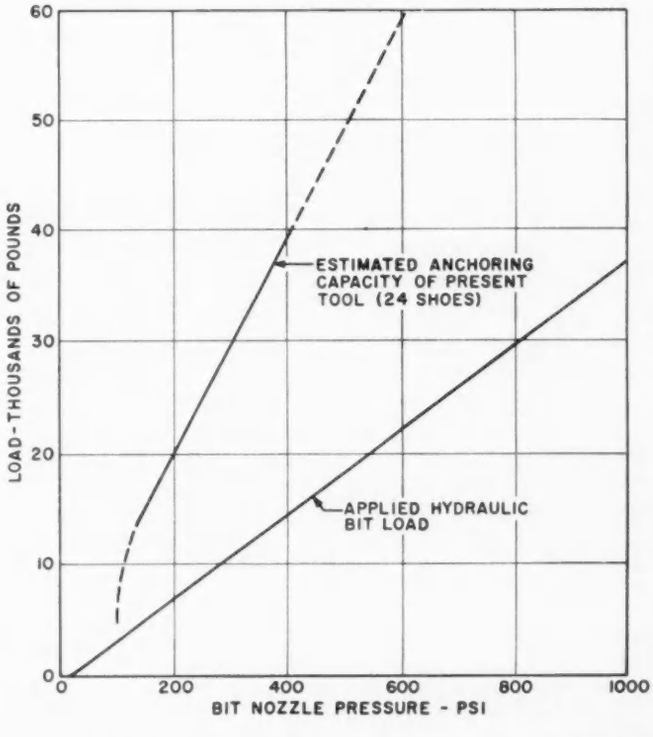

FIGURE 5—Comparison of the applied bit load and anchoring capacity.

Although these tests were conducted in soft laminated shale and sandstone formations instead of in the harder formations for which the tool was designed, the results were exceptionally good. Each shoe was found to be capable of anchoring more thrust than it could safely carry for long periods of time. For this reason, the number of shoes used in the tool was based on safe shoe thrust load rather than on anchoring capacity. Figure 5 shows the estimated anchoring capacity of the

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tool to be well above the maximum loads to be anchored.

High-pressure anchor shoe. The initial anchor tests encouraged the development of the high-pressure anchor shoe. Static pressure tests of the prototype showed that it would withstand 2,750 psi before failing. This indicated that, because of the physical properties of rubber used, the shoe would have a working pressure of at least 1,250 psi. Additional calculation predicted that each shoe should safely support a vertical thrust load of about 1,500 lbs.

The extension characteristics of the high-pressure shoe are such that the present tool can tolerate a hole one inch overgage before it fails to anchor. Figure 6 shows the pressure-extension curve for a typical anchor shoe.

Shallow drilling tests. A series of shallow tests has been made using a 1,000-psi pressure drop across the bit. These tests showed that:

- Seal life is good —100-hour minimum
- Anchor shoe life is reasonable—65 hours
- Hole enlargement should not be a critical problem.

These results were obtained from 2,300 feet of shallow drilling in 275 rotating hours to depths of 700 feet, using water as the circulating fluid. The formations drilled varied from laminated shales and sandstones to medium hard limestones.

The seals were routinely changed after about 100 hours of operation, although they appeared to be in excellent condition. The life quoted for the anchor shoes is based on limited use of the present design. Actually, these shoes have had no operational failures and show little change in quality after this amount of use.

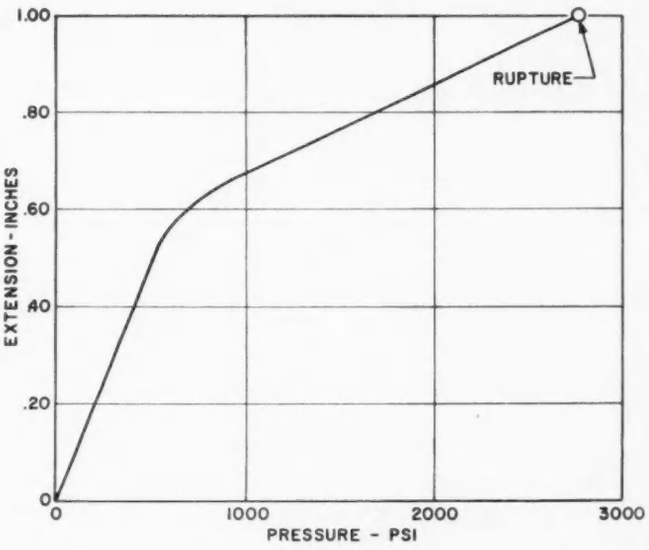

FIGURE 6—Pressure-extension curve for a typical anchor shoe.

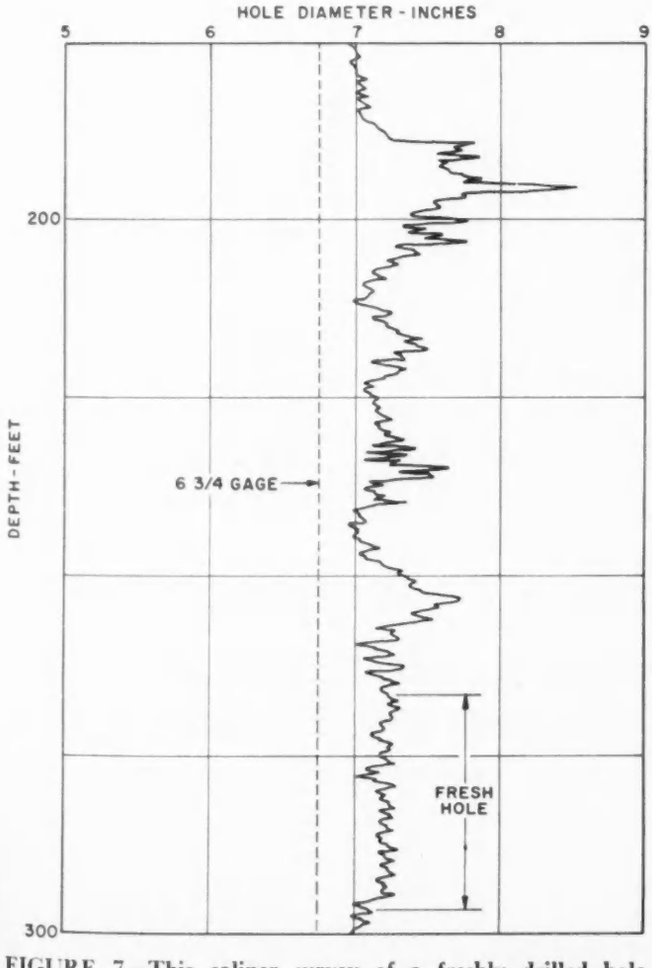

FIGURE 7—This caliper survey of a freshly drilled hole shows very little washout characteristics just above the bit.

A caliper survey (Figure 7) of a hole freshly drilled through the softer shales showed that the tool was anchoring satisfactorily in a hole being drilled ½ inch overgage. After several days of circulating, hole enlargements developed, as shown above the freshly drilled section in Figure 7. The excessive enlargement shown at 195 feet was in a coal streak and indicates the tool can drill through such formations without experiencing an anchoring failure. These results are substantiated by caliper surveys in West Texas, including the red bed formations, which indicate that most hole enlargement usually occurs at least 50 to 100 feet above the bit.

ECONOMICS

A preliminary analysis indicates that the tool becomes economic if the life of the seals, anchor shoes, etc., is greater than approximately 100 hours. This is based on the estimated savings in trip time and drill collar maintenance, as compared to the cost of replacement parts. Resetting-time loss was not considered, as it represents a small portion of the drilling time for hard formations. Also, this time loss could be reduced by increasing the length of the stroke.

In the economic analysis, the initial investment costs were not considered. Since a hydraulic wall-anchored drill collar should cost 50 to 70 percent less than drill collars required to give equivalent bit weight, the initial cost savings appear to be very favorable.

This article was condensed from a paper entitled "The Hydraulic Wall-Anchored Drill Collar" and presented at the Petroleum Mechanical Engineering Conference of The American Society of Mechanical Engineers, New Orleans, September 18-21, 1960.

ACKNOWLEDGMENTS

For permission to publish this article, the authors wish to express their appreciation to Jersey Production Research Company, the principal production, drilling, and exploration research affiliate of Standard Oil Co. (N.J.). Acknowledgment is extended to J. M. Camp of Jersey Production Research Company for his aid in designing and testing this tool. The authors are also grateful for assistance received from the staff of Drilco Oil Tools, Inc.

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* If you count the pictures, you come to number 9. But that's certainly not the total of packers made by Baker. For instance, Models "J" & "K" Snap-Set Packers are also made in double-grip versions. Model "E" is also offered with integral one-shot unloader, or with unloader and hold-down. Moreover, thanks to Baker's continuing program of packer research and development, new packers that will supplement the packers pictured above are coming.

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Model "J" Single-Grip Snap-Set Dual Packer
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(right)
Model "K" Single-Grip Snap-Set Dual Packer
Product No. 756-K

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DRILLING RIG in the Ordos platform bordering Inner Mongolia.

Red China claims large oil resources are being developed

Yumen, Yenchang and Tuschantzu fields are active. New fields found at Karamai, Lenghu and elsewhere

By Robert Westgate

IN 10 YEARS Red China has boosted oil production from around 2,000 barrels daily to about 60,000 barrels per day. Between 1950 and 1957, production increased at an annual rate of from 20 to 27 percent. But in the past two years the annual rise has reportedly been of the order of 50 percent. Natural crude accounts for most of the country's output, although important quantities come from coal and shale, of which China has very big resources.

When the Communists came to power in 1949, the Chinese industry was turning out between 1,800 and 2,000 barrels daily. (Record wartime production under Chiang Kai-shek was 6,300 barrels daily.) By 1952, output had reached 8,600 barrels daily, and by the end of the country's first five-year plan in 1957, it had been increased to 28,800 barrels daily. Production in 1958 was 44,200 barrels daily. By the end of September, the Chinese press reported, 1959 production exceeded the total 1958 output.

These figures are based on a conversion factor of 7.2 barrels per metric ton.

Exploration. But more significant than actual Chinese production at the present time is the prospecting they have done in recent years—and are still doing—and the success they claim in this field. According to Li Jen-chun, vice-Minister of the Petroleum Industry, preliminary exploration for oil resources shows that China has a minimum potential annual capacity of over 2 million barrels of petroleum per day, and possible oil-bearing structures have been found in one quarter of the country's land area.

During the past 10 years, Li Jen-chun wrote in a recent issue of a Peking paper, a survey for petroleum has been carried out on ½ million square miles, and the aggregate well drilling reached more than 11 million feet. (In 1958 3,875,000 feet of deep

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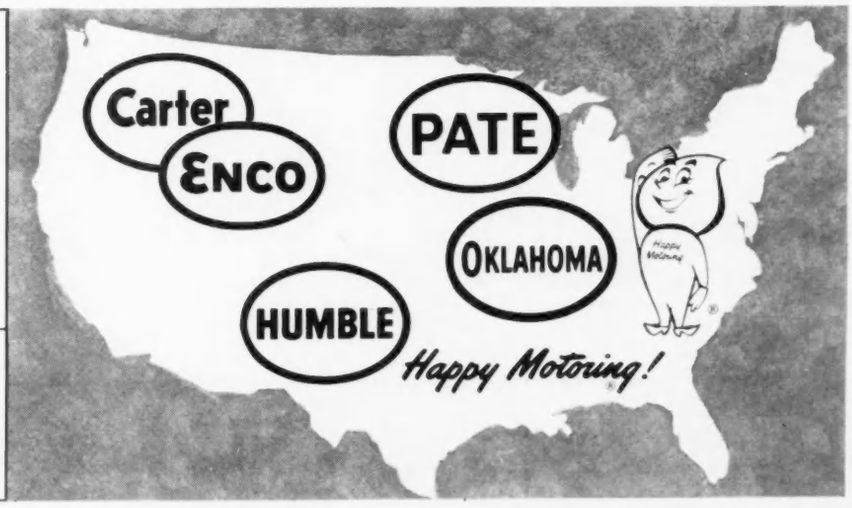
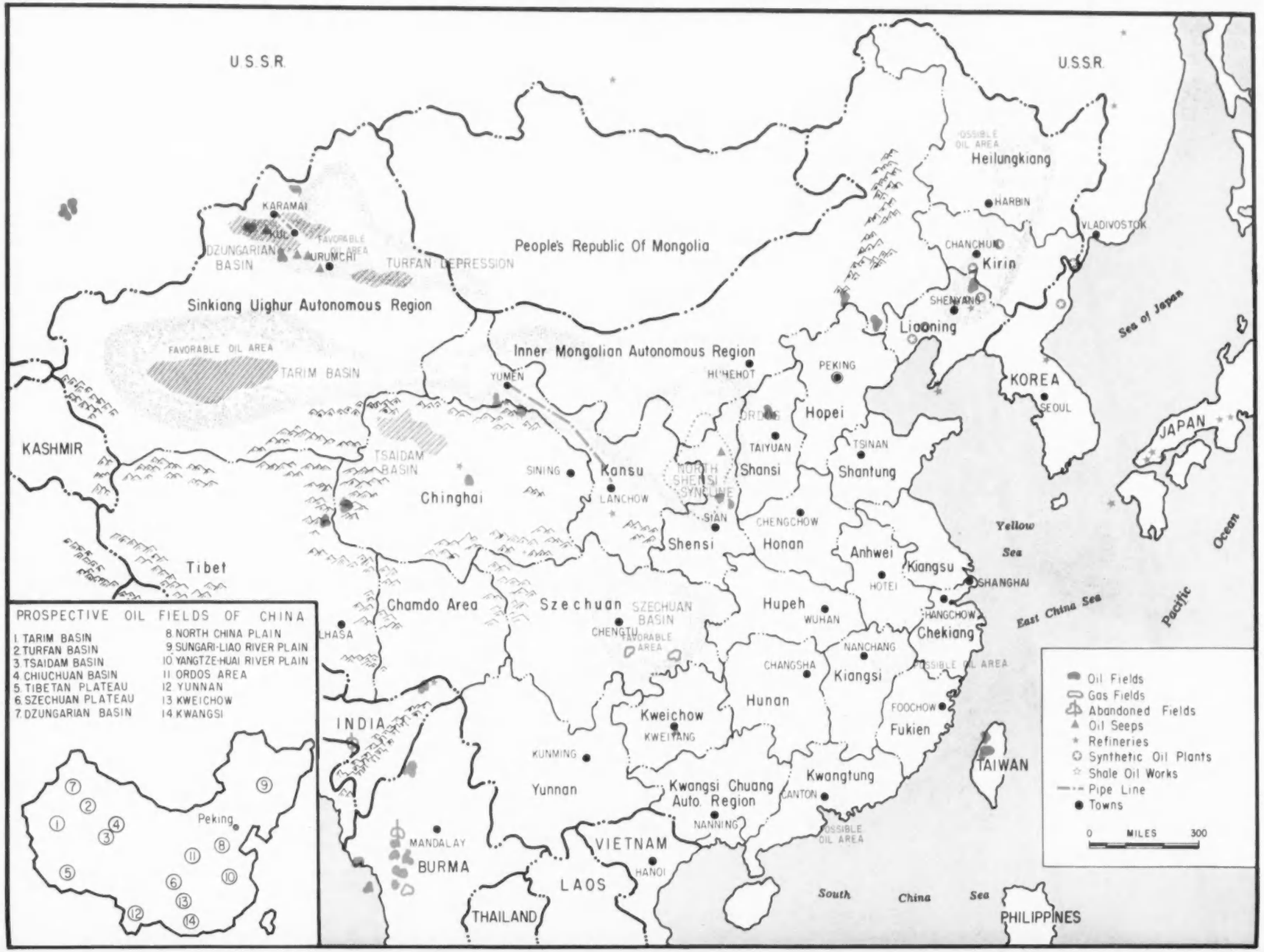
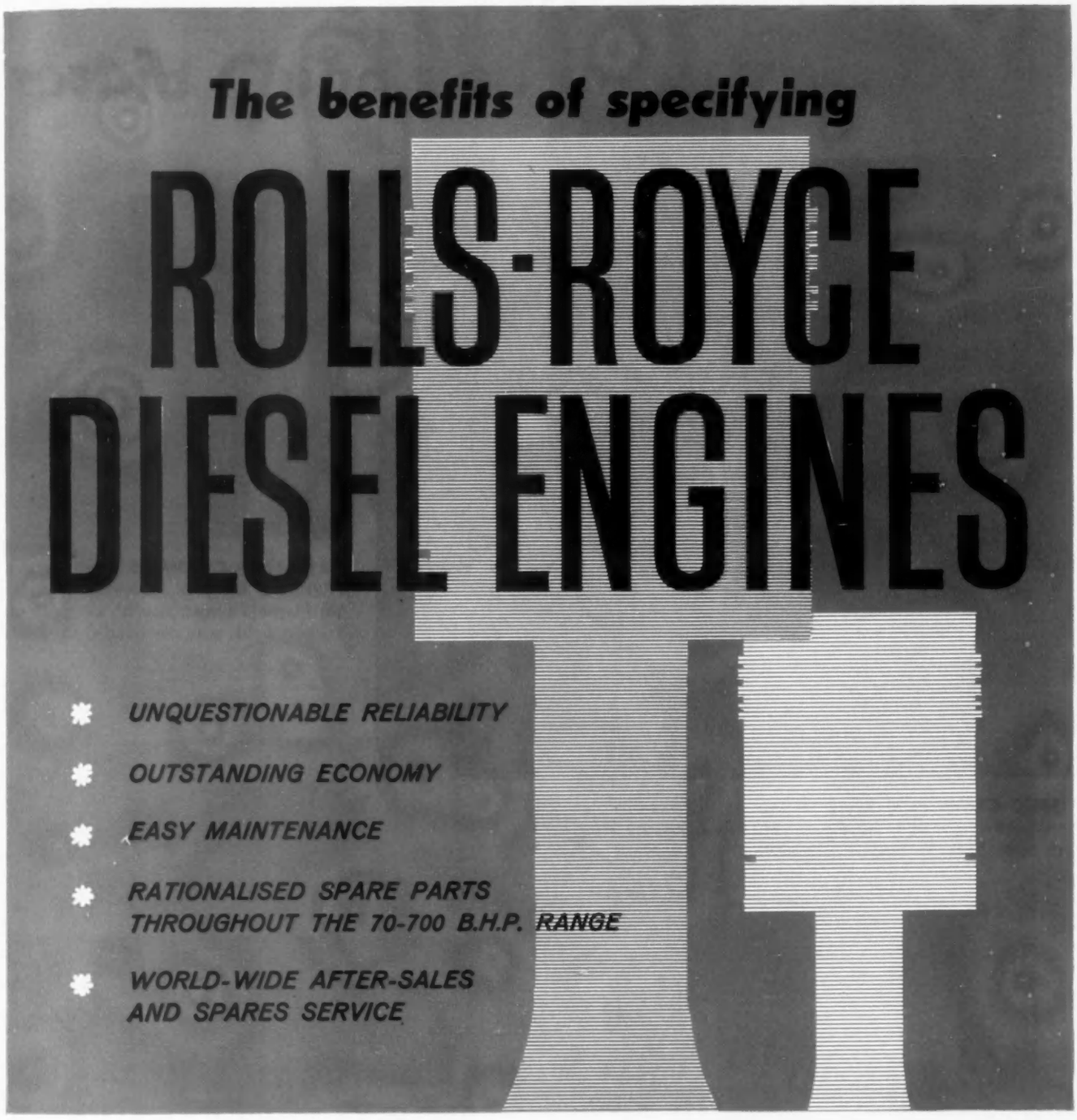


Sedimentary Basins and Established Fields Promise Important Oil Industry in China





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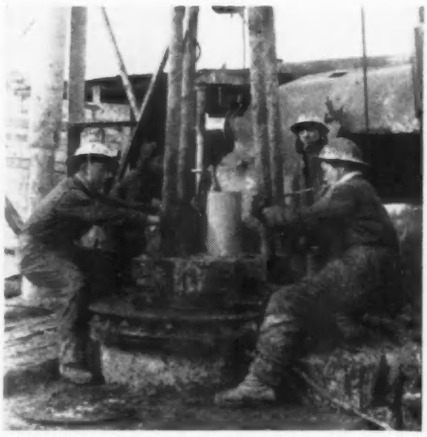
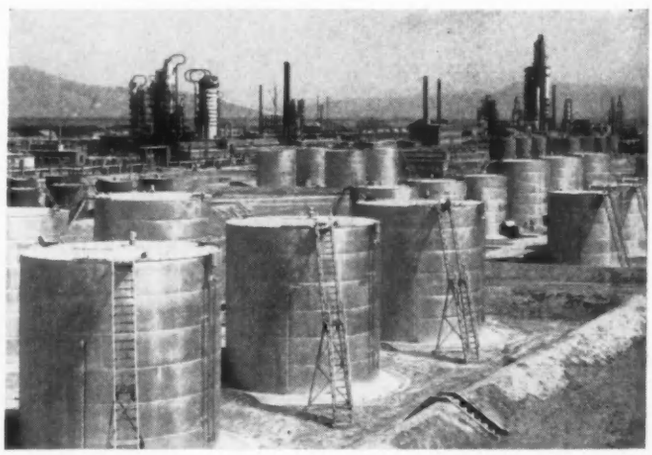
Faces

SEISMIC CREW prospecting for oil in the Ordos platform, bordering Inner Mongolia. Many oil-bearing structures have been located in the area.



DRILLING CREW at work in the Yaerhhsia oil pool, Kansu Province, northwest China. Yaerhhsia, part of Yumen field, was discovered in 1956.

TRANSPORTATION is a problem. China has few pipe lines and large quantities of crude oil from the remote northwest are carried by road. Here trucks are taking crude oil from Lenghu to Lanchow refinery.



LANCHOW REFINERY in Kansu Province is big and modern. The refinery began operating late in 1958. It processes 7.2 million barrels of crude a year (20,000 bpd). This refinery was built with Russian help.

# of Red China's oil industry

CHINA'S WOMEN are playing an important part in the labor force in Karamai oil field of northern Sinkiang. Here two women inspect separating equipment.

OIL PROSPECTORS examining specimens of animal life collected in the vast and promising Ordos platform area on the border of Inner Mongolia.

TYPICAL WORKERS in China's oil industry are these two former army men (left) listening to instructions from skilled worker at the Yumen oil center.

DRILLING FOR OIL in the Turfan basin of Sinkiang Province. Oil-bearing formations, oil sands and seepages have been found in the area.

oil drilling was completed). Through large-scale surveying and prospecting in recent years, the Yumen, Yenchang and Tushantzu oil fields in Kansu and Shensi Provinces have been expanded, and new fields have been discovered at Karamai in Sinkiang Province, Lenghu in Chinghai Province, and in central Szechwan Province. In addition, many promising oil bearing structures are reported to have been found in northeast, north, east and south China and on the Sikang-Tibet plateau.

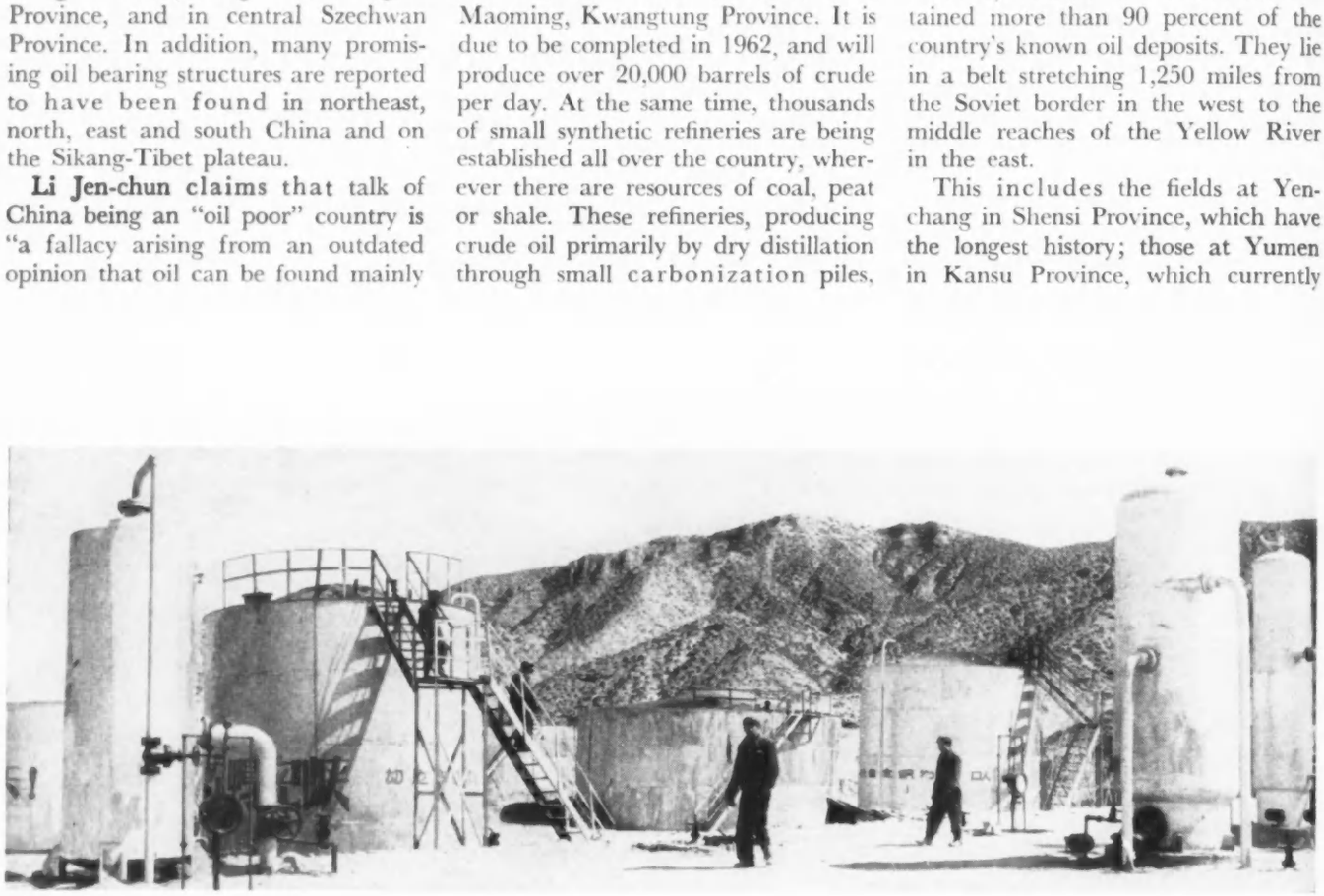
Li Jen-chun claims that talk of China being an "oil poor" country is "a fallacy arising from an outdated opinion that oil can be found mainly in strata of the Cenozoic era, sea facies and geosynclinal structure." In China, he says, rich oil reserves have been found in strata of the Mesozoic and Paleozoic eras, continental facies and platform structure. He cites as examples the Karamai and central Szechwan fields, two of the largest newly discovered in China. At the present time many geologists are out in the field exploring China's petroleum and other mineral resources. They are organized in survey parties and equipped with modern laboratories for chemical analysis and machine repair shops. Modern methods of geophysical and geochemical prospecting are employed.

Shale Oil. To boost output, the Chinese are currently placing equal emphasis on the production of both natural and synthetic oil. China has a big and old-established shale oil refinery in Fushun, Liaoning Province, and a giant, integrated oil shale works is now under construction in Maoming, Kwangtung Province. It is due to be completed in 1962, and will produce over 20,000 barrels of crude per day. At the same time, thousands of small synthetic refineries are being established all over the country, wherever there are resources of coal, peat or shale. These refineries, producing crude oil primarily by dry distillation through small carbonization piles, have annual capacities ranging from 1 to 3 barrels per day each. Medium sized synthetic refineries with capacities of about 200 barrels a day have been built in a number of interior provinces.

Coal. China has huge coal deposits, estimated at around two million million tons, and the oil content of much of this coal is as high as 46 percent. Oil shale reserves, claimed to exceed 360,000 million tons, have been found in practically all of China's provinces. These reserves alone, spokesmen for the Chinese oil industry have declared, ensure an annual output of 1.2 to 1.6 million barrels of oil per day for 50 years.

Four major fields. To date there are four known great oil fields in China—Karamai, Yumen, central Szechwan and Tsaidam—and the Chinese say they do not yet know which is the largest. Prior to the discovery of the central Szechwan fields in 1958, China's vast northwest contained more than 90 percent of the country's known oil deposits. They lie in a belt stretching 1,250 miles from the Soviet border in the west to the middle reaches of the Yellow River in the east.

This includes the fields at Yenchang in Shensi Province, which have the longest history; those at Yumen in Kansu Province, which currently provide the largest volume of production; Wusu in Sinkiang Province, which yields the best quality; the Tsaidam Basin of Chinghai Province, where production began in 1958, and the Karamai field in northern Sinkiang, which also started regular production in 1958.



NO. 4 TANK BATTERY completed at Yumen oil field in May 1959.

Karamai. The Karamai pool is a kind of stratigraphic trap in a rock formation of the lower Jurassic era. Conditions for boring in the field are good. There have been very few cases of wells caving in, freezing of the drill pipe, or high-pressure subterranean water. Wells have been drilled by using low-gravity mud, and most of them are relatively shallow.

High grade lubricants are refined from Karamai crude. Karamai is now established as the biggest field so far discovered in Sinkiang.

Late in 1958, a new oil field of industrial value was found in the Uerho area, 80 miles northeast of Karamai, and since then drilling has indicated that Karamai and Uerho are linked in one big field. This means an oil-bearing district extending over an area of about 1,500 square miles.

The most optimistic Chinese reports have suggested that the whole of the Dzungarin Basin, in which the Karamai field is located, may prove to be oil-bearing, and that more fields on the scale of Karamai may be found. The entire Dzungarin Basin extends over an area about two-thirds the size of Rumania.

More recently Karamai has begun to make use of oil-bearing sand and shallow oil formations. From these sources, surveys reportedly show, over 200 million barrels of crude oil can be produced. Karamai production has made Sinkiang Province self-sufficient in oil, and shipments of crude to other parts of China began early in 1959. In the past 12 months about 4,000 barrels per day of crude and refined oil have been sent to Lanchow by the new Sinkiang-Lanchow railway. A trans-shipping station has been built at Hungliu River, the first station on the railway in Sinkiang, where truck loads of crude are re-pumped on to trains.

On the basis of a known reservoir area of more than 25,000 acres or about 40 square miles, the Karamai field is scheduled to have an output of more than 60,000 barrels of crude per day by the end of 1962. (The aim was to treble production in 1959).

An oil pipe line began operating at the Karamai oil field at the beginning of 1959. It is about 90-miles long, and links the oil field with the Tushantzu refinery in northern Sinkiang, 125 miles west of Urumchi. The pipe line is made of seamless tubes welded together and has three pump stations. It took eight months to build. A subsidiary line has since been laid to cope with the increasing output from Karamai. The Tushantzu refinery is now being extended, and a new refinery is under construction in Karamai.

Sinkiang Basins. Chinese geologists believe that the Tarim Basin in southern Sinkiang is also a promising oil field. A test well in this area flowed

About the Author

Robert Westgate is a New Zealander. As a free lance journalist he has made a special study of economic and industrial development in Communist China and has written on this subject for numerous trade, technical and business journals in Britain, the United States and Europe. He lived for a number of years in London, contributing to various British and European publications. He now lives in Auckland and edits Management, one of New Zealand's business magazines.

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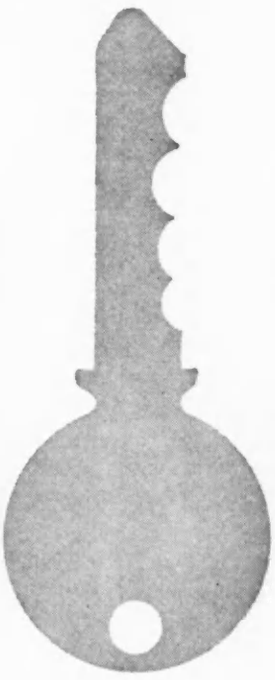

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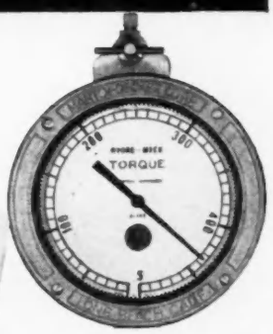

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For some time, too, prospecting has been going on in the Turfan Basin, to the south of Urumchi, Sinkiang's capital. Last year 720,000 barrels of crude oil (2,000 barrels daily) was expected to be produced from the "Flame Hills" in the Turfan Basin, where over 2,000 oil workers were searching for oil and developing the oil field. The "Flame Hills," located along the Lanchow-Sinkiang railway, have been confirmed as a promising oil field of about 57,000 acres or 90 square miles. The first test well has been yielding 108 barrels of crude daily during the past year.

Sinkiang, China's biggest and most remote province, is scheduled to become a major oil base. So far, more than 60 small refineries have been established north and south of the Tien Shan Mountains.

Tsaidam Basin. Virtually unexplored before 1954, the Tsaidam Basin covers an area of 54 million acres or 85,000 square miles in the northwestern part of Chinghai Province. Oil was first found in the area in 1955, and since then the Chinese have claimed that the basin has turned out to be "an ocean of oil." During the past five years over 120 geological structures promising oil have been discovered. On more than 40 of these structures nearly 300 wells were drilled, and 229 of them yielded oil or gas.

Many of the oil-bearing structures in the area are economically workable, and the Shihtzukow structure alone is said to have an estimated oil reserve of 220 million barrels. Since July 1958, 1,080 barrels of crude oil have been produced daily from the No. 2 well in the basin. Late in 1958, three new flowing wells were reported from the area, and more than 725 barrels of crude oil daily flowed from each of them.

Lenghu is now the key prospecting area in the basin. Here there are 10,000 workers sinking test wells and recovering oil. Lenghu is situated at the terminus of the projected Lanchow-Chinghai railway, and conditions for producing oil are better than in other parts of the Tsaidam Basin. Producing wells, tank batteries and a 12-mile pipe line were completed early in 1959. The first refinery in the area came into operation in August 1959. There are now five refineries in the basin, the biggest being in the Yuchuantzu prospecting area, at the western end of Tsaidam. In August, 1959, it was claimed, output from the Tsaidam Basin reached 7,200 barrels daily.

Yumen. The Chinese say that rough surveys have shown that the oil bearing area in the Yaerhhsia oil field, a new field discovered in Yumen in 1956, is more than double that in the Laochunmiao oil field, the major field in the Yumen district. Production from the Yaerhhsia field began in 1959, and is expected to double Yumen's output of crude. Some of the wells are reportedly flowing more than 720 barrels of crude a day. Reports from the area in 1959 referred to "scores of oil drilling teams," using high speed drilling methods to drill their quota of more than 100 new wells during the year. Some months ago one of the crews set a new record, drilling 3,300 feet in four days. A new refinery, completed in just under three months, is producing gasoline, diesel oil and petroleum.

Szechwan. The central Szechwan oil field was discovered in March 1958, and about 720,000 barrels of crude

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was produced up to the end of 1958, an average of 2,700 barrels daily. It is refined in Shanghai, but refineries are now being built in Szechwan. So far, oil has flowed from 19 test wells in the area and one of the best wells flows 1,500 barrels a day.

Other areas where the Chinese are concentrating drilling include the Ordos grassland region of Inner Mongolia, eastern Szechwan, parts of Kweichow Province, Hainan Island, and the Sungliao Plain in northeast China.

Sungliao Plain. This plain, with a total area of approximately 96,500 square miles along the Sungari and Liao rivers, has been proved a promising area for oil reserves after three years of prospecting. A number of oil-bearing structures have been located as a result of aerial magnetic, geophysical and other advanced oil exploration, carried out with the aid of Soviet and Hungarian experts.

In the plain there are deep, thick layers of sedimentary rock from the Mesozoic and Cenozoic eras. The area has become a key one for prospecting because the eastern part of China has considerable industry and good transportation facilities.

Lanchow refinery. China's first big modern refinery is in Lanchow, a rising industrial centre in Kansu Province. It processes 7.2 million barrels of crude a year (20,000 barrels daily) from the Karamai and Yumen fields. The refinery, which began operating at the end of 1958, was designed and built with the help of the Soviet Union, which also supplied major machinery and equipment. Production processes are highly mechanized and automatically controlled.

A petroleum drilling and refining machinery plant is also under construction in Lanchow.

Nanking refinery. A bigger refinery than that at Lanchow has been built in Nanking. It was scheduled for completion in the first-half of 1960. It will have an annual capacity of up to 22 million barrels (60,000 barrels daily), and will take crude from central Szechwan. This refinery will produce aviation fuel, motor spirit, kerosine and lubricating oils. A number of chemical plants will make use of by-products.

The Ministry of the Petroleum Industry has announced that thousands of medium and small-sized refineries are to be built during the second five-year plan period (ending in 1962).

Currently the Chinese industry is making about 100 petroleum products, including many produced for the first time in the past two years. They include aviation gasoline, aviation kerosine, aviation lube oils, transformer oil, turbine oil and other high-grade oil products.

Equipment. China claims to be 90 percent self-sufficient in oil prospecting, drilling and production equipment. Equipment being made includes precision geophysical instruments and drilling rigs. A 10,500-foot deep well drilling rig went into serial production at the end of 1958.

A Sian (northwest China) factory specializing in geophysical prospecting instruments began production in 1956. It makes electric logging units, seismic instruments and gravity meters. In

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1959, it started mass producing a gas logging instrument, an auto-electrical logging instrument, a radiometer, apparatus for determining velocity by ultrasonic waves, an auto-electrical instrument for field work, a high speed thermal logging instrument, a low frequency seismodetector and a low frequency seismograph.

A workshop under the Sinkiang Petroleum Administration in Urumchi recently made China's first lightweight seismograph, suitable for prospecting work in deserts, marshes, etc. It weighs 160 pounds. Factories in the Yumen oil field are turning out more than 40 kinds of petroleum machinery.

In addition to the Soviet Union, Rumania, Czechoslovakia, Eastern Germany and Hungary have all played a part in the development of the Chinese petroleum industry, either by supplying equipment or by contributing technical know how. (China takes from the other Communist countries over 80 per cent of her imports of drilling equipment and 96 percent of her petroleum imports).

An agreement concluded in 1950 between the Soviet Union and China set up a Sino-Soviet Oil Corporation to exploit Sinkiang's resources. When the corporation came under complete Chinese ownership in 1955, it had its own power plant, repair shop, oxygen plant, refinery and cracking plant.

Continuing Soviet assistance to the Chinese industry takes the form of co-operation in the building of petroleum enterprises, prospecting and research. Of the 78 major industrial concerns now being built in China under a Sino-Soviet agreement concluded in February 1959, a number are for the petroleum industry. At the same time, Chinese specialists are in the Soviet Union studying the multiple use of natural gas and doing research work in oil shale.

Research. Scientific research for the oil industry has developed in China with the expansion of the industry. Following the establishment of the Institute of Petroleum of the Chinese Academy of Sciences, a Petroleum Research Institute was set up in Peking, and a number of oil research institutions were set up in other areas of the country.

More recently, an Academy of Geological Research was established in Peking by the Ministry of Geology, to supplement the work of the Institute of Geology under the Chinese Academy of Sciences. The institute stresses theoretical research, but the new academy will be concerned equally with theory and technical problems. One of its functions is to "map out the general direction in the search for minerals, including ferrous and non-ferrous metals, non-metallic materials and coal, phosphorus and petroleum." The academy has six institutes, an exhibition centre and a library.

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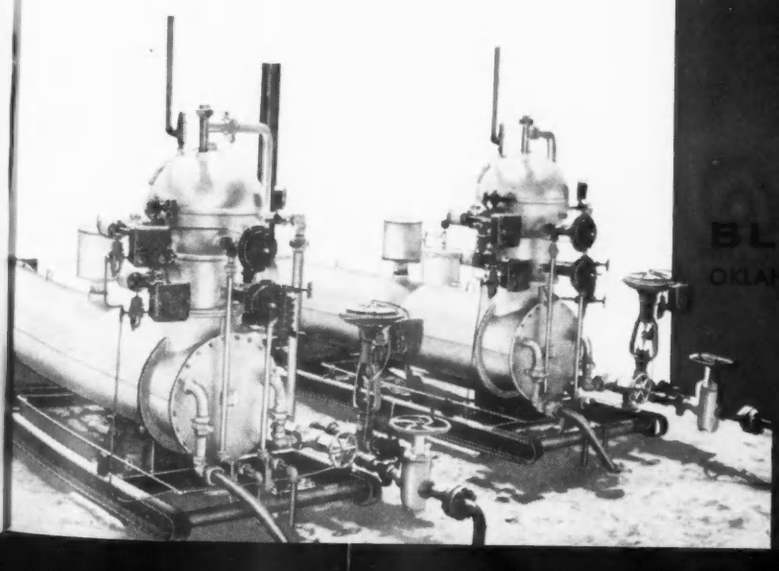
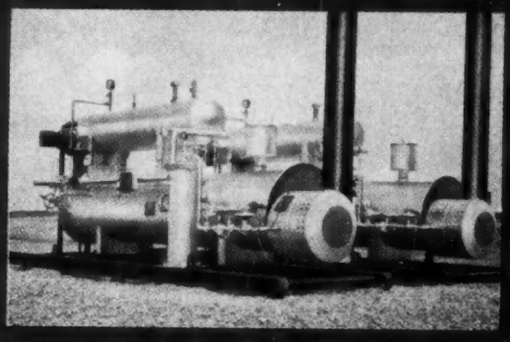
These spherical separator heater units each process 2 to 4 MMSCFD of gas with 18 bbls. of oil and 2 bbls. of water per MM. They have seen two hard winters. There were no freeze-ups. Displacement element for water dump is hung vertically, completely immersed in the liquid section, making for easier control of interface of oil and water. Submerged liquid section has sufficient area to warm the liquid in it, but there is little heat transferrence to upper gas section. Lower liquid is kept warm independent of sales gas temperature. Wellstream is preheated in the heater flow coil before choking to prevent hydrate formation in the separator.



Prevents equipment freeze-ups, shut-downs and service calls



These horizontal separator heaters each handle production amounting to 4 MMSCFD of gas, 15 bbls. of oil and 1 bbl. of water per MMCF. Production has been sometimes ... winter and summer months. Heat ... to keep liquid from freezing in the separator. This is accomplished by piping the inlet gas through a coil in the liquid section of the separator.

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C. V. Helm

W. A. Triest

New Air Drilling Company Organized in Fort Worth

Formation of a firm specializing in air drilling services and equipment on the international scene, has been announced by president of the new company, C. V. Helm.

The new firm, International Air Drilling Company (INTAIRDRIL), has general offices in Fort Worth. European headquarters are located in Brussels, Belgium. The company will specialize in providing a fully integrated air drilling service to oil companies operating overseas.

Vice president of the new firm is William A. Triest, a veteran air drilling specialist who was formerly with Gardner-Denver Company.

Intairdril was formed to take air drilling know-how and equipment to any location in the free world as a service to oil operators. The organization provides engineering services and specialized equipment for air-mist-aerated liquid and gas drilling operations.

Pan American Petroleum Corp. Reorganizes Canadian Districts

Pan American Petroleum Corporation has reorganized its Canadian producing and exploration functions into two new joint districts and has announced personnel changes involved in the formation of the new districts. The new districts are headquartered in Calgary and Edmonton and will supervise all of Pan Am's activities in Canada.

The new Calgary exploration and production district, with headquarters in the Bentall Building, Calgary, covers all activities in Manitoba and Saskatchewan, that part of Alberta south of Edmonton and west of Swan Hills and all of British Columbia south of Fort St. John and west of the Rocky Mountain Trench.

The new Edmonton exploration and production district includes Pan Am properties and activities in the Northwest Territories, the Yukon, Northern Alberta and Northeast British Columbia. Offices for the Edmonton district are housed in the Bentall Building, Edmonton.

Concurrent with the formation of the Calgary district, Pan Am also established a new production area, designated the Whitecourt area, with offices in Whitecourt, Alta.

Personnel changes involved with the new operating districts include the appointment of Gus Athanas as Calgary district superintendent in charge of producing operations. He was formerly Pan Am's Pembina Area superintendent. Other new appointments include that of J. D. Burns, who becomes Pembina area superintendent, replacing Athanas. The new Whitecourt area superintendent is E. R. Wagner. G. J. Last has been named district engineer for the Calgary district producing operations; A. S. Anderson has been appointed Edmonton production district clerk; F. W. Just has become Calgary production district clerk, and G. E. Goss has been named Edmonton area clerk.

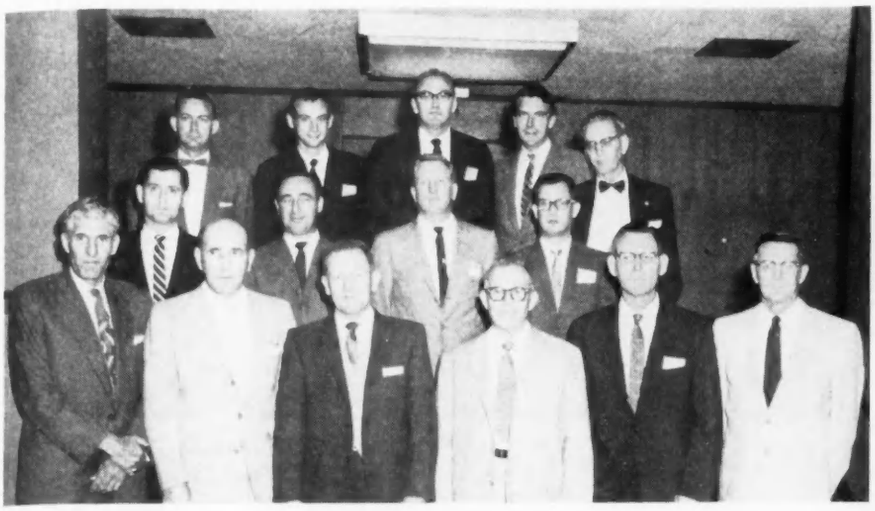
Guatemala Gives Approval To Delhi Corporation

Delhi Guatemala Exploration Corporation, subsidiary of Delhi-Taylor Oil Corporation, has been approved by the Guatemalan government as operator for the El Peten group which is conducting exploratory activity in northwestern Guatemala.

The group, composed of Delhi Guatemala Exploration Corporation, Guatemalan Atlantic Corporation, Guatemalan Sun Company and Pure Oil Company of Guatemala, has concessions in two areas comprising approximately 1,337,000 acres. The group to date has conducted only geological and geophysical operations.

S. S. HOPE Is Commissioned

The privately financed medical school ship, S. S. HOPE, was commissioned in San Francisco recently. Present for the occasion was L. F. McCollum, president of Continental Oil Company, and chairman of the board of Project HOPE, Vice President Richard M. Nixon, and Dr. William B. Walsh, Washington, D. C., physician, founder of the project.



Guests and Speaker at Los Angeles NOMADS' Meeting

International guests and speaker at a recent meeting of the Los Angeles Chapter of NOMADS were, left to right, front row: Bill Middlestead of Camdrill from Algeria; Ed Thatch of I.P.C. from Qatar; Fred Gholson of I.P.C. from Iraq; R. V. McCann of D & E from Libya; Jack Parker of Camdrill from Libya; John Sligh of D & D from Venezuela. Middle row: Frank Bragg, speaker; Jack Veny of Parker Drilling of Canada from Canada; Stan Nelson of Stanvac from Sumatra; Enrique Dominguez of Signal Oil & Gas from Venezuela. Back row: B. J. Turner of Kuwait Oil Company from Kuwait; Bernard Marrey of Baker Oil Tools from France; Robert G. Waters, ex-Aramco from Saudi Arabia; Robert Linton of C.P.F. (A) from Algeria, and Zeke McCoy of Caltex from Holland.

Geophysicists Name 1960-1961 Officers

The Southwest Louisiana Geophysical Society of Lafayette, La., recently elected new officers. Elected were, from left to right, front row: Charles B. Vidrine, second vice president; Glynn Schuchardt, president; Bill Flowers, first vice president. Standing: John Murphy, secretary; Dick Hollenbaugh, past president, Glen Hunter, treasurer.

Anderson-Prichard Awaits Approval of Stockholders

Roland V. Rodman, president of Anderson-Prichard Oil Corporation, and Mark J. Millard and Richard T. Lyons, chairman of the executive committee and president, respectively of Union Texas Natural Gas Corporation, have announced in New York that an agreement had been entered into which, if approved by the stockholders of Anderson-Prichard, will result in the sale of all of its assets and the distribution to its stockholders of $50 per share before payment of expenses relating to the transaction.

Under the terms of the agreement, Anderson-Prichard will receive $123,300,000 for its properties, $80 million of which sum arises from the sale of Anderson-Prichard to Brookston Oil Company of production payments reserved from oil and gas leases involved in the transaction.

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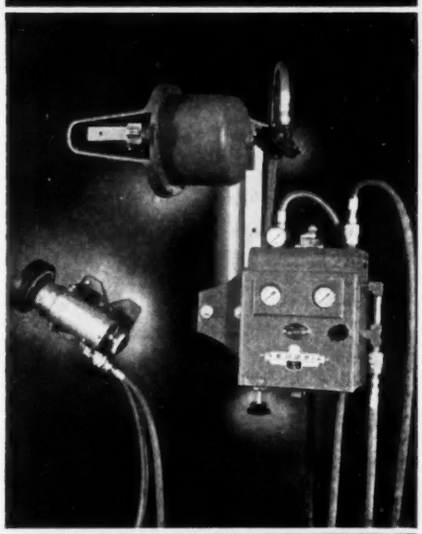

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Houston NOMAD Visitors

The Houston Chapter of Nomads hosted 18 international guests at a recent meeting. Guests who were present were, front row left to right: Roberto Sanchez, Camco de Mexico; J. Munoz, Petroleos Mexicanos, Mexico; Luis Costa, Shell Oil Company, Venezuela; Peter Touma, Iraq Petroleum Company, Kirkuk, Iraq; Robert Busking, Asiatic Petroleum Company, Houston; Wendell Black and Guy Woodruff, Tennessee Overseas, Argentina, and L. Adamsen, Gulf Oil Company, Angola, Africa. Standing left to right: Wes Bourdo, K. L. Bourdo Company, Tripoli, Libya; Manuel Bracho and German Viera, Shell Oil Company, Venezuela; B. Woodford, Camco, Canada; George Ratcliffe, Asiatic Petroleum Company, London; Roy Dillon, British American Oil Company, Calgary, Can.; Paul Fleming, Gulf Oil Company, Sicily; Robert Ferguson, Udell, Inc., Mexico; C. Wen Shen, Chinese Petroleum Company, Taiwan, and Art Prell, Mene Grande Oil Company, Venezuela.

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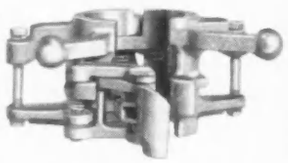

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New R&D Plan Announced By Nationwide Leasing Company

A special R&D (research and development) Lease Plan for petroleum companies engaged in government contract work has been announced by Nationwide Leasing Company.

The R&D lease features terms of from three to five years, according to Robert Sheridan, president. A cancellation clause is available if desired. This is the first standard cancellation clause to be offered in lease contracts. Leases may range from $25,000 to $1 million or more.

Both standard and custom-built equipment may be leased under the R&D lease. Types of equipment that can be leased include: environmental test equipment, electric gear, business machines and office equipment, machine tools, general production equipment, laboratory equipment and processing equipment.

"The purpose of this R&D lease plan is to enable companies to participate in the great research and development program now underway without tieing up working capital they need for their normal operations," Sheridan said.

Men in the industry

J. H. Casey

J. H. Poe

John C. Thompson, comptroller and treasurer, **Mobil Oil de Venezuela,** has been elected to the board of directors. Also, **J. Howard Casey, Joseph H. Poe, Hamilton P. Caldwell** and **Karl F. Madsen** have been elected new vice presidents of the company. Casey will be vice president for producing; Poe for finance and industrial relations; Caldwell for manufacturing, and Madsen for marketing.

J. C. Thompson

Feisal Mansour Mazidi and **Mahmoud Khalid al-Adasani** have been appointed directors of **Kuwait Oil Company Limited.**

Dudley Tower has been elected president of **Union Oil Company of California.** Tower, who had been executive vice president, succeeds **Reese H. Taylor.** Tower joined the company in 1935. Later, he became district manager for the company's operations in Houston. In 1946 he was named manager of operations for the Gulf Coast Division. In 1953 he became a vice president. In 1955 he was appointed vice president in charge of field operations. He was elected to the board in 1956 and was named executive vice president last April. Tower will continue to maintain his headquarters at Union Oil's main offices in Los Angeles.

Harry Jordon has been appointed office manager of the International Department's Las Palmas, Canary Islands, Exploration and Production Office for **Phillips Petroleum Company.** The Las Palmas office will be headquarters for Phillips operations in concessions recently granted to the company in the Spanish Sahara of North West Africa.

Michael A. Stone has joined the staff of **Stephens Engineering,** Petroleum Engineers, Wichita Falls, Texas.

M. A. Stone

A. Rowland Boucher has been appointed vice president and chief of geological research for **King-Stevenson Oil Company, Inc.** Boucher will headquarter in Denver.

M. W. Sherwin, formerly with Sohio Petroleum Company, has entered the geological consulting field with offices in Bellaire, Texas, and in the Milner Building in Jackson, Miss.

R. P. Harder, executive assistant with the general staff of **Sinclair Oil & Gas Company's** Geological Department, Tulsa, has been appointed division geologist with the South Texas Division in Houston. Also, **A. D. Brixey, Jr.,** division geologist at Houston has been transferred to the North Texas Division at Fort Worth. He will report to **J. K. Lydecker,** recently appointed exploration superintendent. **W. D. McEachin,** division geologist at Fort Worth, has transferred to Tulsa where he replaces Harder as executive assistant with the general staff and will report to **Dr. J. L. Martin, Jr.,** chief geologist.

Merrill W. Haas has been appointed to the newly created position of vice president for exploration of **Humble Oil & Refining Company.**

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Baash-Ross Drill Collars are stress relieved to prevent bending in operation due to internal stresses.

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Impact tested to assure attainment of the desired metallurgical characteristics.

Thru the years these qualities of Baash-Ross Drill Collars have proven to be essential for maximum Collar life.

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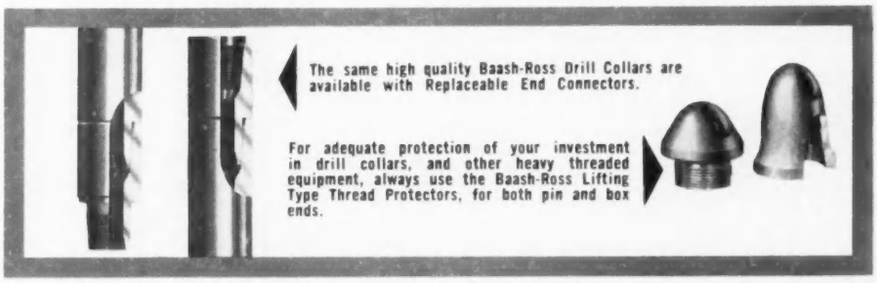
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DIVISION OF JOY MANUFACTURING COMPANY

General Offices: Houston, Texas

Men in the industry

Merle E. Minks has been appointed chief counsel of **Wilshire Oil Company of** California.

Frank E. Merrill, Jr., has been promoted to supervisor, Administrative Procedures on the staff of the general manager of **Texaco Inc.'s** Domestic Producing Department at Houston. Merrill succeeds the retired **J. C. Brooks.**

H. T. Hunter has succeeded retired **Russel G. Bechtel** as Rocky Mountain Division production superintendent for **Pan American Petroleum Corporation** in Casper, Wyo.

E. A. Hugill, Jr.

P. H. Swinchatt

E. A. Hugill, Jr., has been named to succeed **P. H. Swinchatt,** assistant to the president of **Shell Oil Company** and vice president of **Shell Pipe Line Corporation,** when Swinchatt retires December 31, after already 40 years service with Shell. Hugill is currently secretary of Shell and also secretary of **Shell Chemical Company, International Lubricant Corporation** and **Shell Canadian Exploration Company.**

WHO'S MEETING WHERE

Nov. 3–4	AAPG, Pacific Section, Annual Meeting, Ambassador Hotel, Los Angeles.
4–7	National Oil Jobbers Council, Meeting Congress Hotel, Chicago.
6–9	Texas Oil Jobbers Association, Management Institute, Baker Hotel, Dallas.
7–10	SEG, Thirtieth Annual International Meeting, Moody Convention Center, Galveston, Texas.
–11	Industrial Engineers Conference, Rice Hotel, Houston.
12–16	API, Fortieth Annual Meeting, Conrad Hilton Hotel, Chicago.
14–16	SPE of AIME, Venezuelan Sections, Fourth Annual Meeting, Maracaibo, Venezuela.
1–16	API, Board of Directors Meeting, Conrad Hilton Hotel, Chicago.
16	API, Executive Committee of Board of Directors, Conrad Hilton Hotel, Chicago.
21–22	SPE of AIME, Formulation Evaluation Conference, Cullen Auditorium, University of Houston, Houston.
27 to Dec. 2	ASME Annual Meeting, Statler Hilton Hotel, New York.
Dec. –8	Public Affairs Conference, Sponsored by West Texas Oil Information Committee of the Texas Mid-Continent Oil & Gas Association, Midland Women's Club, Midland, Texas.
–9	Fifth Annual Program on "Mineral and Tidelands Law," Tulane University Law School, Tulane University, New Orleans.
Jan. 9–13	SAE International Congress and Exposition, Cobo Hall, Convention Center, Detroit.
–20	Natural Gasoline Association of America, Gulf Coast Regional Meeting, The Robert Driscoll Hotel, Corpus Christi, Texas.
22–24	Kansas Oil Men's Association, Forty-Sixth Annual Convention, Broadview Hotel, Wichita, Kan.
Feb. 5–10	ASTM Committee D-2 Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.
8–10	The Southwestern Legal Foundation, Twelfth Annual Institute on the Law of Oil, Gas and Taxation, Southwestern Legal Center, Dallas
–24	Natural Gasoline Association of America, South Louisiana Regional Meeting, Lafayette Petroleum Club, Lafayette, La.
26 to Mar 2	Society of Petroleum Engineers of AIME Annual Meeting, Chase & Park Plaza Hotels, St. Louis, Mo.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Biltmore Hotel, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Elbert T. Walker, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

H B

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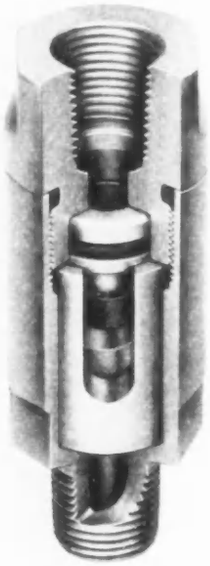
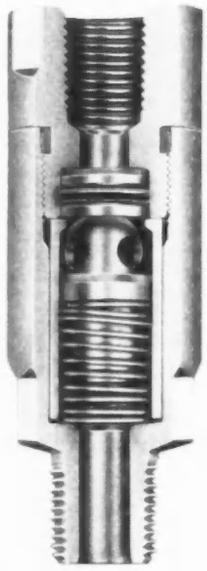
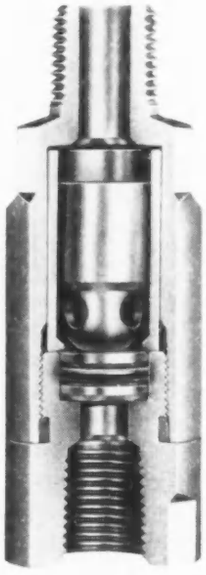
• Protect the heart of gas lift valves with Harold Brown normally seated check valves. Available in three types—"AM" Magnetic Check Valve—"B" Gravity Check Valve—"S" Spring loaded Check Valve.



Type "AM" Magnetic Check Valve
Positive Ball Seal
Non-weakening magnetic action
Insert seat, easily replaced
Made from Monel and high nickel alloys



Type "S" Spring Loaded Check Valve
Spring protected from flow stream
Heat treated K-Monel insert seat
Long life Monel spring



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Associations

AAODC Selects New Officers for 1961

New officers for 1961 were selected by the directors of the American Association of Oilwell Drilling Contractors at their Twentieth Annual Meeting in New Orleans. New officers are, seated left to right: C. B. Webster, Dale Mount, Rarle C. Hellums, John J. Moran, Warren L. Baker, and Joseph M. Shelton. Standing, left to right: C. H. Todd, George B. Kitchel, Paul F. Rutledge, M. L. Vance, John R. Burns, John S. Hagestad, James H. Phillips, Jr., R. C. Tucker. Not pictured, F. M. Stevenson, J. J. Harrigan and J. K. Maxwell.

AAODC Elects J. J. Moran New President for 1961

John J. Moran, chairman of the board of Moran Bros., Inc., and vice president of Moran Drilling Company, both of Wichita Falls, Texas, was named 1961 president of the American Association of Oilwell Drilling Contractors at the Twentieth Annual Meeting of the organization. Moran will succeed W. L. McClusky of M. J. Delaney Company.

Earle C. Hellums, president of Gracey-Hellums Corporation, Houston, was named national vice president. Other officers include: Warren L. Baker, executive vice president, Dallas; F. M. Stevenson, Signal Drilling & Exploration, Inc., Denver, vice president for Cable Tools; R. C. Tucker, Great Western Drilling Company, Midland, Texas, vice president for West Texas and New Mexico; John S. Hagestad, John S. Hagestad Drilling Company, Bakersfield, Calif., vice president for California; John R. Burns, Burns Drilling Company, Evansville, Ind., vice president for Illinois, Michigan, Indiana and Kentucky; C. B. Webster, C. B. Webster Drilling Company, Houston, vice president for Gulf Coast; C. H. Todd, The R. W. Rine Drilling Company, Wichita, Kan., vice president for Central Mid-Continent; Paul F. Rutledge, Rutledge Drilling Company, Santa Fe, N. M., vice president for Rocky Mountains; J. J. Harrigan, Standard Drilling Company, Inc., Oklahoma City, vice president for Well Servicing; J. K. Maxwell, Carter-Jones Drilling Company, Inc., Kilgore, Texas, vice president for Cretaceous and Tertiary Basins; James H. Phillips, Jr., King-Phillips, Inc., Fort Worth, vice president for North and West Central Texas; G. B. Kitchel, Kerr-McGee Oil Industries, Inc., Houston, vice president for offshore; E. Dale Mount, Dale Mount Drilling, Inc., Dallas, secretary-treasurer, and Joseph M. Shelton, Dallas, general counsel.

The AAODC Meritorious Service Awards, designed to pay a special tribute to persons who have advanced the science and status of the oil well drilling industry, were awarded to George F. McQueen, chairman of the board of McQueen & Stout Drilling Company, and to George P. Livermore, owner of Livermore Drilling Company.

W. C. Fatjo, owner of W. C. Fatjo Drilling Company, and James H. Phillips, Jr., were presented plaques for their outstanding contributions to the AAODC.

American Petroleum Institute Sets Sights on Chicago

Addresses by leaders in the fields of business, industry, government and education, and presentation of the Gold Medal for Distinguished Achievement, will highlight the Fortieth Annual Meeting of the American Petroleum Institute, November 14-16, in Chicago.

The API Gold Medal, symbolic of outstanding service to the oil industry, will be presented to this year's recipient at the general session on Wednesday, November 16.

M. J. Rathbone, chairman, API Board of Directors; president, Standard Oil Company (New Jersey), New York, and Arthur H. Dean, Sullivan and Cromwell (Attorneys), former chief U. N. truce negotiator in Korea, New York, will be speakers at the general session on November 16. Tentatively scheduled to speak at API general sessions are: Senator James F. Murray, Jr., director of finance, Jersey City, N. J.; Frank M. Porter, president of API, and William F. Kenney, vice president and general counsel, Shell Oil Company, New York, and chairman of the API Committee on Public Affairs.

The Division of Production sessions

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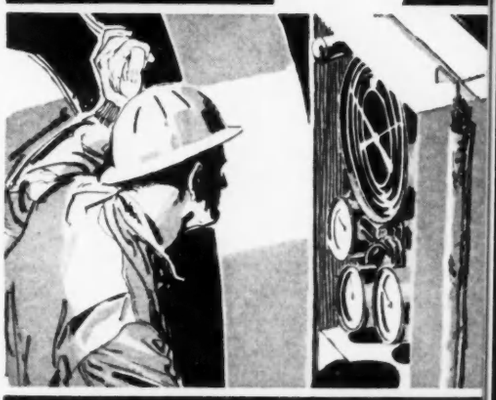

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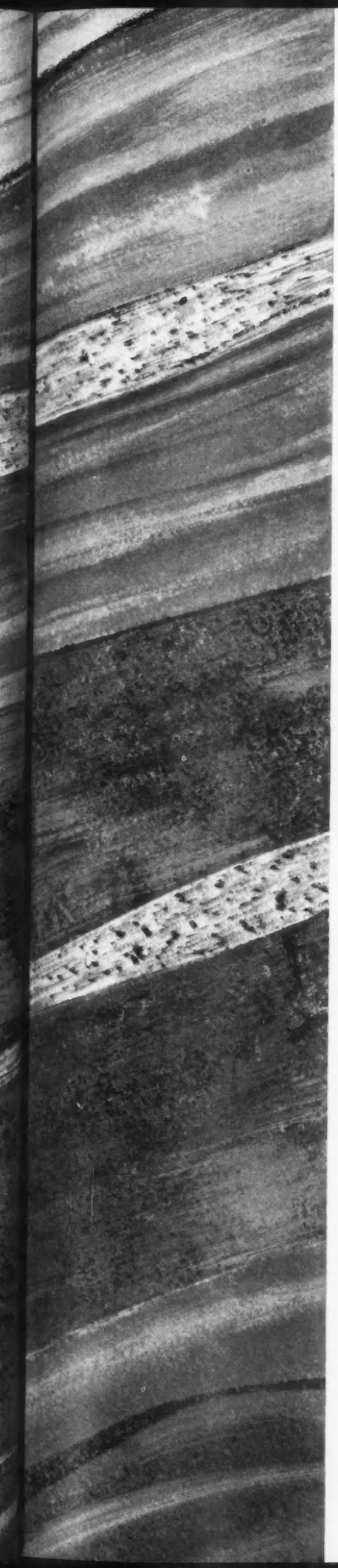
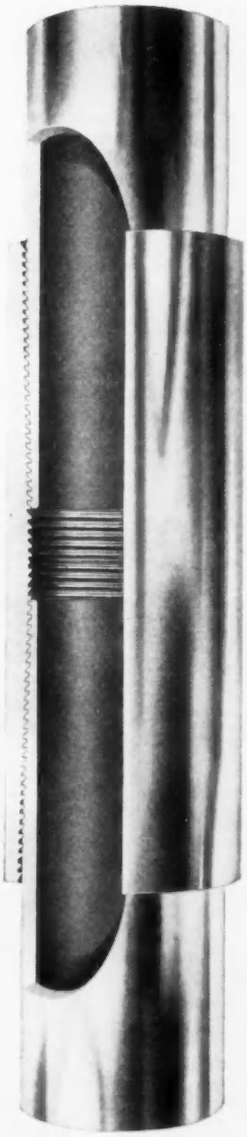


Something new
in the oil country



USS National Buttress-Thread Tubing

National Tube, developer of Buttress-Thread Casing, now introduces Buttress-Thread Tubing.

This new joint has tensile strength comparable to that of the body of the tubing. Since there is no upset, you get maximum hole clearance and less interference when running. Rugged, flat-crested threads have good stabbing characteristics, better resistance to joint damage and faster make-up. Buttress-Thread Tubing has extended life in service because it can be threaded in the field at authorized machine shops. Tin-plated coupling threads offer you gas-tight joints and reduce your make-up torque. For complete information on Buttress-Thread Tubing, write or call National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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This mark tells you a product is made of modern, dependable Steel.

will be held in the Conrad Hilton Hotel. The preliminary program shows the following schedule:

GROUP SESSION
Tuesday, November 15
1:45 p.m.—Conrad Hilton, Grand Ballroom

Presiding: L. E. Fitzjarrald, Vice President for Production, American Petroleum Institute; Vice President, Phillips Petroleum Co., Bartlesville, Okla.

Presentation of API "Certificate of Appreciation."
By L. E. Fitzjarrald, API Vice President for Production.

Address:
Minor S. Jameson, Jr., Independent Petroleum Assn. of America, Washington, D. C.

Address:
R. M. Williams, Phillips Petroleum Co., Bartlesville.

Address:
E. B. Miller, Jr., Tidewater Oil Co., Houston.

Address:
John Stetson, Booz, Allen and Hamilton (Management Consultants), Chicago.

Address:
Lloyd E. Elkins, Pan American Petroleum Corp., Tulsa, Okla.

Address:
Herbert Willetts, President, Mobile Oil Co., New York.

Report of Nominating Committee.
Edgar Kraus, The Atlantic Refining Co., Dallas, Chairman.

Election of Members of General Committee.

COMMITTEE MEETINGS
Monday, November 14, 1960
9 a.m. Executive Committee on Training.
9 a.m. Committee on District Activities.
4 p.m. Nominating Committee, Division of production.

•

Tuesday, November 15
9 a.m. Executive Committee on Drilling and Production Practices.
12 Noon Program Subcommittee (of General Committee, Division of Production) (Luncheon).

•

Wednesday, November 16
12 Noon General Committee, Division of Production (Luncheon).

E. M. Kipp

L. E. Elkins

H. F. Beardmore

R. J. Schilthuis

E. M. Kipp Elected President Of SPE of AIME for 1961

Earl M. Kipp, special consultant-producing problems on the staff of the vice president-in-charge of producing for Standard Oil Company of California at San Francisco, was elected president for 1961 of the Society of Petroleum Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers at the Society's Thirty-fifth Annual Fall Meeting which was held October 2-5 in Denver. At the same time, Lloyd E. Elkins, production research director for Pan American Petroleum Corporation, was elected to serve as 1961 president-elect of AIME.

Herbert F. Beardmore, Houston District manager, Production Department, Gulf Oil Corporation, was presented the Certificate of Service from the SPE. Beardmore's selection for the honor was based on his long and active leadership in the professional society for petroleum engineers. Wayne E. Glenn, president of the SPE and production manager for Continental Oil Company, made the presentation.

Ralph J. Schilthuis, executive vice president and member of the board of management of the Humble Division of Humble Oil & Refining Company, was awarded the 1960 John Franklin Carll Award.

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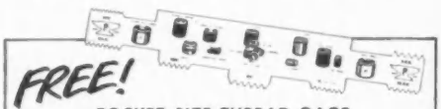

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Subsidiary: Anvil Products, Inc., Longview, Tex.
Affiliate: Canadian Coupling and Fittings, Ltd., Simcoe, Ont.

Suppliers' notes

A. C. West, Jr.

Charles T. Jones

Charles T. Jones has been named general manager and **A. C. (Bus) West, Jr.,** has been named sales manager of **Oil Center Tool Company.** Jones' new responsibilities will be in addition to those of vice president. He had previously served as vice president and sales manager. West formerly had held the position of Western Region sales manager.

Craig L. Davis has been elected president of **Catawissa Valve & Fittings Company.** Davis joined the pipe union and valve manufacturing firm in 1946 as plant engineer. The election resulted at the firm's recent annual meeting of stockholders.

B. W. (Bill) Wheeler has been appointed executive vice president and general manager of the **McGaffey-Taylor Corporation,** a wholly owned subsidiary of the **Eastman Oil Well Survey Company.** Wheeler has been associated with the McGaffey-Taylor Corporation for the past 14 years as part owner, vice president and field manager.

A. T. (Johnny) Johnson has been transferred from district manager of the Houston District to district manager of the Oklahoma City District for **Bowen Itco, Inc.** Also, **Tommy Farr** has been appointed district manager at Houston; **Bob W. Evans** was appointed field salesman of Oklahoma City District; **Fred McMillian** was transferred from Houston to store manager at Oklahoma City; **Donnie Davis** has been promoted to store manager at Casper, Wyo., to district manager at Varnal, Utah; **Kenneth Hobbs** was promoted from store manager to district manager at Hobbs, N. M., and **Aubrey Teeter** is the new store manager at Hobbs.

J. B. (Jake) Waltermire has been appointed by **Gulf Coast Machine and Supply Company** of Beaumont, Texas, as their representative in Lafayette, La. Waltermire comes to Gulfco with many years experience as drilling superintendent and related positions in the Gulf Coast area.

Walter W. Edens has been appointed assistant director of the Research Division of **Allis-Chalmers Manufacturing Company.** He had been supervisor of metallurgical research.

E. S. Dulin

E. S. Dulin has retired as chairman of the board of **Byron Jackson Division of Borg-Warner Corporation.** Dulin served as president of Byron Jackson from 1929 until 1958, and has been board chairman since 1945.

George L. Flint has been appointed product development engineer for **Lone Star Steel Company.** Flint will be responsible to **L. G. Graper,** vice president, operations, research and development, and will coordinate product diversification with **Walter T. Moreland,** vice president—sales.

W. E. Willis has been appointed district engineer at Clay City, Ill., and **Earl L. Bundy** was appointed area manager-production equipment sales, Evansville, Ind., for **U.S. Steel's Oil Well Supply Division.**

Top Executives of Engineering Enterprises, Inc.

Officers and directors of the new firm, Engineering Enterprises, Inc., left to right are: John M. Winterbotham, Marvin Eickenroht, M. U. Broussard, R. W. Abercrombie, Fred K. Fox, W. H. Skipworth, Jr., J. E. Teddlie, J. W. Lander, Jr., John C. Allred and W. F. Wright, Jr. Not pictured is Nick Furnace.

Suppliers' notes

Walter Henry

Ross B. Baze

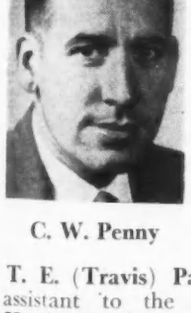
Walter Henry and **Ross B. Baze** have been appointed to high-level executive posts with **Rolo Manufacturing Company** of Houston. Henry was appointed assistant general manager and elected to the board of directors. Baze joined the firm to serve as vice president—sales.

J. V. Moynes has been appointed Southwest Regional sales manager for **Morse Chain Company.** Moynes will headquarter in Houston. His territory will include Texas, Louisiana, Mississippi, Oklahoma and Southern New Mexico.

Andrew F. McNally, Jr., has been appointed manager-Manufacturing for **General Electric's** Steam Turbine Department. He had been superintendent of large machining and eretcion in G-E's Large Steam Turbine-Generator Department.

Rolland E. Sanders, Jr., has been named chief engineer for **The Service Recorder Company. Sanders** will have a key role in diversification and development of new products.

C. W. **Penny** has been appointed vice president and general manager of **General Geophysical Company (Bahamas), Ltd.,** Tripoli, Libya. It is a subsidiary of the parent firm **General Geophysical Company,** Houston. Penny has been vice president of the firm's South American subsidiaries in Caracas, Venezuela, and Bogota, Colombia.



C. W. Penny

T. E. (Travis) Parish has been named assistant to the general manager of **Hughes Tool Company.** In his new position, Parish will represent Hughes management on special assignments and in community and industry activities and relations.

E. E. Stanley has been appointed district representative at Denver for **U. S. Steel's Oil Well Supply Division.**

Eugene P. Berg was elected executive vice president following a meeting of the board of directors of **Bucyrus-Erie Company. Berg** previously was employed as general manager of all Chicago operations of the Link-Belt Company.

Harold E. Parsons, former Rocky Mountain Division manager, **The Western Company,** has been named vice president in charge of South America Division, and will headquarter in Buenos Aires, Argentina. Also, **Donald Walters** will replace Parsons at Farmington, N.M. Walters was formerly assistant division manager at Midland, Texas; **B. J. Bucy** has been named technical assistant to the executive vice president in Fort Worth. He was division engineer at Oklahoma City. **Jean Barrett,** formerly division sales manager at Oklahoma City, will assume duties as city sales representative in Dallas, and **Laddie Harp,** acting division sales manager at Midland, will become division sales manager at Oklahoma City.

K. W. Dudley

Kenneth W. Dudley has been appointed chief engineer at the Torrance, Calif., plant of **The National Supply Company.** Dudley succeeds **Forrest J. Young,** who has retired. Dudley started with the company as a draftsman in 1941. In 1948 he was appointed a design engineer. He has been a project engineer since 1949.

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The Camco-King Time Cycle Controller provides fully automatic time cycle and pressure control of intermittent gas injection operations on offshore or other unattended installations. Pneumatic operation virtually eliminates any possibility of mechanical failure. Camco-King Controllers can be used on any installation requiring automatic opening and closing of motor valves on a predetermined time schedule.

A bellows-activated shut-off valve is available as optional equipment for tubing or casing pressure control. The Camco-King Controller is operated with ordinary injection gas pressure and can be mounted on any type Camco motor valve. By simply reversing a check valve in the line and mounting the controller on the correct type valve, control action can be changed from direct to indirect.

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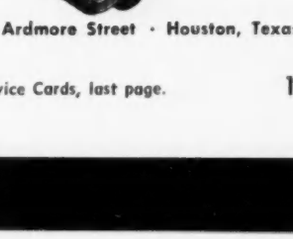


C-609

P. O. Box 14484 · 7010 Ardmore Street · Houston, Texas

Suppliers' notes

R. D. Wood, logging engineer at Farmington, N.M., for **Schlumberger Well Serveying Corporation,** has been promoted to sales engineer at that location. Other changes in field personnel are: **R. D. Knapp,** formerly sales engineer at Andrews, Texas, has been transferred to the firm's McCamey, Texas, location, and **M. R. Curtis** has been named location manager at Kimball, Neb. He had been assigned to Casper, Wyo.

E. R. Koberg, export sales manager for **Bryon Jackson Tools, Inc.,** has been made a vice president of the firm. He will headquarter in London.

C. R. Boll

Reece Hatchitt

C. R. Boll has been appointed to the newly created position of executive vice president-marketing, and **Reece Hatchitt** has been appointed to the newly created position of vice president-International Operations for **Cummins Engine Company, Inc.**

Norton Moore has been appointed project engineer of **Tex-Tube, Inc.** Moore will supervise the introduction of new projects and services produced by Tex-Tube's research and development group.

Basil J. Storrar has been appointed sales manager of the **Edwin Cooper & Company, Ltd.,** a member of the **Castrol Group of Companies.**

Kenneth Brierley and **John H. Hagen** have been appointed new general managers for two of **Minneapolis-Honeywell Regulator Company's** Industrial Products Group Division. Brierley assumes responsibility for expanding activities of the Fall River, Mass., Division, and Hagen succeeds to Brierley's former post as head of the Rubicon Division. Also, **George W. Hoffmeister** changes from general superintendent of the Fall River unit to the Datamatic Division in Boston in a staff assignment.

John M. Fry is a new sales repreeentative in western Oklahoma and the **Texas** Panhandle for **Union Wire Rope Corporation.** Fry will headquarter in Oklahoma City and report to **G. E. Giese,** branch manager in Oklahoma City. Fry will have the territory formerly handled by Giese until his promotion to branch manager. Union Wire Rope is a subsidiary of **Armco Steel Corporation.**

John M. Fry

R. W. Reekstin has been appointed manager-Hydraulic Sales for the **Axelson Division of U.S. Industries, Inc.,** at Los Angeles. Reekstin will be responsible for the entire hydraulic sales and service organization, including offices and warehouses in Long Beach, Calif., and Odessa, Texas.

Joseph J. Jacobs, C. L. Babb and **W. W. Weltmer** have been given new appointments by the **Allis-Chalmers Manufacturing Co.'s** Centrifugal Pump Department, West Allis Works, Wis. Jacobs, former assistant chief engineer, is now chief engineer; Babb, former chief engineer, is now senior staff engineer, and Weltmer, had been engineer-in-charge of research and development of the Centrifugal Pump Department, is now senior development engineer.

J. W. Bozeman was recently elected chairman of the board of directors for **Tube-Kote, Inc.** Other corporate officers named were: **E. G. Holm,** president; **J. L. McConn,** vice president and assistant treasurer; **R. S. Martin,** vice president-operations; **L. C. Edgar,** vice president-technical manager, and **I. D. May,** treasurer and assistant secretary.

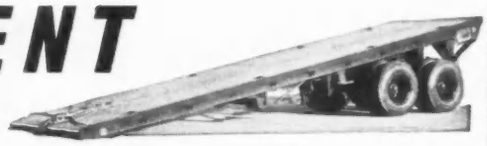
OILFIELD TRUCK AND FLOAT

Thornycroft Sandmaster 252" wheel base Oilfield Truck. Hands-England full Oilfield Body. 60,000 lb. winch, heavy duty gin poles, winch operated gin pole risers and folding SAE king pin.

Hands-England 75,000 lb. capacity, tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.

Truck and Float on Michelin 18.00 x 25. Sahara "X" sand tires.

OILFIELD TRANSPORTATION EQUIPMENT



OILFIELD FLOAT

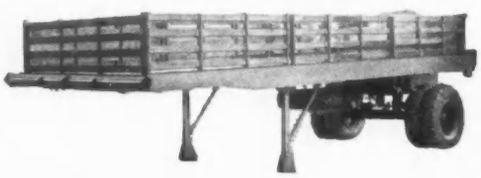
Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 8' 6" wide, folding support legs and inverted 36" fifth wheel. Float on 11.00 x 20 — 14-ply tires.

OILFIELD TRUCK AND FLOAT

Scammel Constructor 261" wheel base Oilfield Truck.

Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.

Truck and Float on 14.00 x 20—18-ply tires.



OILFIELD FLOAT

Hands-England 25,000 lb. capacity single axle Oilfield Float 24' 0" long and 8' 0" wide, folding support legs and SAE king pin 11.00 x 20—12-ply tires. Steel stake sides.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD. Works Road, Letchworth, Herts., England.

Telephone: Letchworth 600 Telegrams: Oil, Letchworth. Cables: Oil, Letchworth, England.

B.M.I.

another
TRETOLITE SERVICE
report

Squeeze Treatment Doubles Oil and Gas Production

The treatment of nine wells on a Texas lease was simple, effective and low in cost—about $300 to $350 per well for TRET-O-LITE demulsifying chemical, pressure pumping truck, and vacuum tank truck. Most of the wells were completed through tubing, with packers set above perforations. Several were dual completions, with two strings of tubing and producing zones separated by packers.

How Tret-O-Lite Chemical Demulsifier was used*

Thirty gallons of TRET-O-LITE demulsifying chemicals were mixed with sixty barrels of lease crude (40° API). This mixture was pumped into tubing of each well, followed by enough crude to allow about 300 feet of oil-chemical mixture to stand in tubing. Each well was then shut in for 18 to 24 hours.

Pays for itself in two days

The figures in the table show how effectively the TRET-O-LITE squeeze treatment increases production in the nine wells.

The increase in production was sufficient to pay for the cost of the total squeeze job in about two days.

WELL	DEPTH	MAXIMUM INJECTION PRESSURE	PRODUCTION BEFORE SQUEEZE		PRODUCTION AFTER SQUEEZE		GAIN BBLS./DAY
			BBLS. OIL/DAY	MCF GAS/DAY	BBLS. OIL/DAY	MCF GAS/DAY	
1	9642	4800	34	153	61	593	27
2	8381	3000	30	5	52	83	22
3	9640	3600	35	224	87	323	52
4	9625	4500	40	672	50	497	10
5	8484	3700	27	339	51	700	24
6	9652	3000	53	35	83	353	30
7	8397	5200	30	32	125	238	95
8	8408	3800	15	12	129	94	114
9	9310	3600	0	0	123	760	123
		TOTAL	264	1472	761	3641	497

Tretolite products are helping to achieve similar savings for thousands of other producers. To find out how you can profit, *ask the Man in the Red Car.*

Or write to . . .

TF-60-6

**Registered trademark, Petrolite Corporation*

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CORPORATION

TRETOLITE COMPANY
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200 South Puente Street, Brea, California

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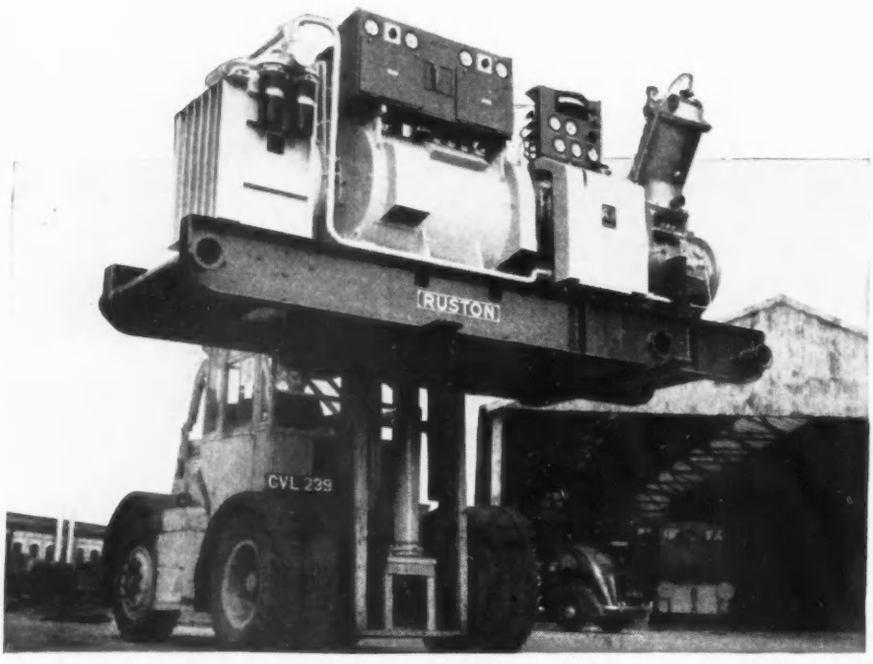
GERMANY, Frankfurt, a. M. • **VENEZUELA**, Caracas

REPRESENTATIVES
ARGENTINA, Buenos Aires • **BRAZIL**, Rio de Janeiro • **COLOMBIA**, Bogota
ITALY, Rome • **JAPAN**, Tokyo • **KUWAIT**, Kuwait • **MEXICO**, Mexico, D. F.
NETHERLANDS, The Hague • **PERU**, Talara • **TRINIDAD**, Port of Spain

300 PORTABLE KILOWATTS

THE RUSTON 'TE' SKID-MOUNTED GAS TURBINE ALTERNATOR SET
is light and completely self-contained.
Weighing only 16,750 lb this long-life air-cooled unit can be moved around—fast! Off the truck, on to the ground, connect the fuel. That's all. You've got 300 kW ready to work for you non-stop . . .
and ready to move on anytime.
Nothing temperamental about this turbine!
Built as a heavy duty unit with a designed blade life of 50,000 hours, it's proving as dependable as the Ruston 'TA'.

The Ruston 'TA', the 1260 b.h.p. turbine with the longest and finest record in oilfield service, is now also available as a skid-mounted unit. Find out more from Ruston!



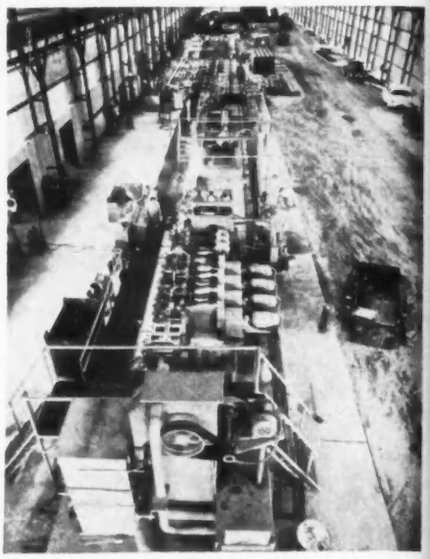
RUSTON GAS TURBINES

430 and 1260 b.h.p. at 80°F. ambient temperature

RUSTON & HORNSBY LTD . LINCOLN . ENGLAND

Associated with Davey, Paxman & Co. Ltd., Colchester

Suppliers' notes



This over-all view of the new electric-weld pipe mill opened by Tex-Tube shows entire production line except for coil-handling equipment.

Tex-Tube, Inc., Opens New Houston Pipe Mill

Tex-Tube, Inc., recently opened a new high-speed pipe mill in Houston. This is the third mill built by Tex-Tube during its 14-year history.

Details of the mill's design and performance were specified by I. Walker Shaw, vice president, Production, and Kenneth C. Woolley, vice president, research and development. Although these men based mill specifications on their own experience and intimate knowledge of virtually every pipe mill in the United States, they personally inspected the most advanced pipe mills in Europe to find worthwhile ideas to incorporate in the new mill.

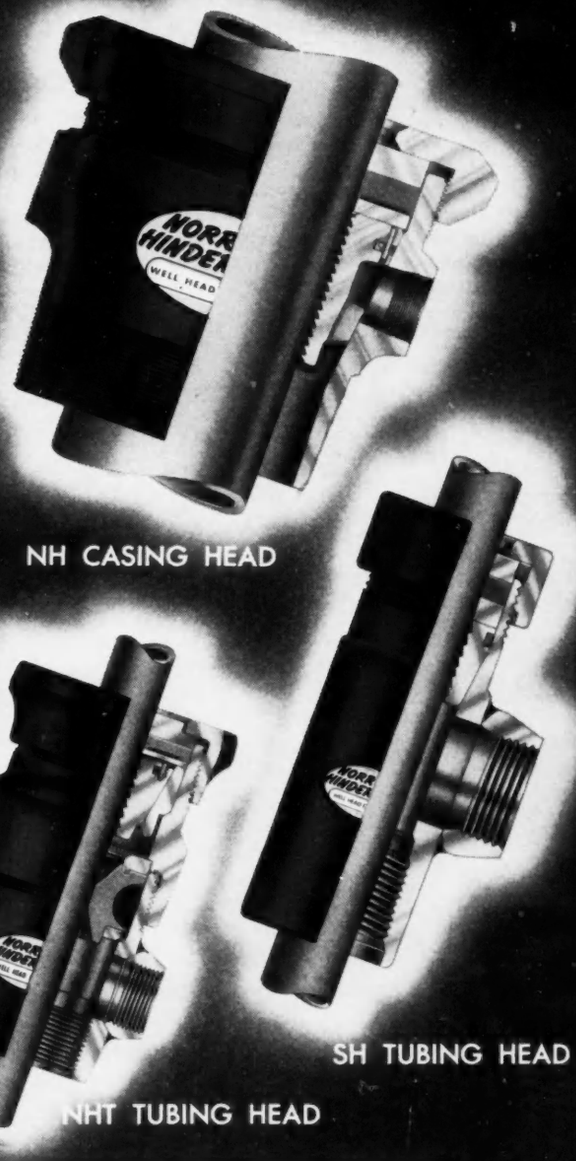
New Drill Collar Firm Is Organized in Houston

Engineering Enterprises, Inc., is the new corporation recently organized in Houston to market non-sticking drill collars for use in the oil industry. The trade name of the product for which patents have been applied is No-Wall-Stick Drill Collars. The drill collar was developed by the new corporation's President Fred K. Fox, and has been in wide use throughout the Texas and Louisiana Gulf Coast for over a year. The incorporation move was made to provide capital for a general expansion program.

Officers of Engineering Enterprises, Inc., are Fox, president; W. H. Skipworth, Jr., vice president and secretary; W. F. Wright, Jr., vice president and treasurer, and Nick Furnace, vice president.

Directors include: John M. Winterbotham, John C. Allred, R. W. Abercrombie, Marvin Eickenroht, M. U. Broussard, J. W. Lander, and J. E. Teddlie. Broussard, chief petroleum engineer, Superior Oil Company, and Ted-

Engineered Simplicity



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SH TUBING HEAD

NHT TUBING HEAD

BUY FROM YOUR NORRIS DISTRIBUTOR

NH CASING HEAD • 4,000 lbs. test — 2,000 lbs. CWP.
Forged steel construction — Slip suspension.
Economical — Flexible — Safe.

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Forged steel construction — Slip or Mandrel suspension — for all Slim Hole completions.

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Full opening — A.P.I. Casing top thread.

NORRIS HINDERLITER
WELL HEAD EQUIPMENT

OTHER W. C. NORRIS CHAMPIONS

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
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BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico; Edmonton, Alberta, Canada.

Suppliers' notes

dlie, general superintendent, Herman & George Brown, Oil & Gas Division, are not stockholders in the new company, but were chosen to represent the drilling industry in general and act in an advisory capacity for the new corporation; therefore, enabling these members to recommend unbiased needs of the drilling industry. These two posts will be rotated annually with new representatives being chosen from operating companies each year.

Headquarters for the company are located in the San Jacinto Building, Houston, with branch offices already established in Lafayette and New Orleans, La.

Ken Corporation Appoints Three New Distributors

Ken Corporation, Long Beach, Calif., recently appointed three new distributors for its line of oil base drilling fluids and pak fluids.

The Alamo Lumber Company with general offices in San Antonio, Texas, sales office in Houston and an engineering office in Corpus Christi, Texas, will represent Ken Corporation in the Gulf Coast of Texas and in South Texas.

The May Brothers of Eunice, La., will distribute Ken products throughout the state of Louisiana.

In the Rocky Mountain Area, Ken Corp., has appointed the United Engineering Corporation, Casper, Wyo., to be its representative. United will cover the oil fields in Wyoming, Utah, Idaho and Colorado.

J&L Supply Division to Distribute Major Equipment

Jones & Laughlin Supply Division has been appointed exclusive distributor in the United States and Canada for automatic lease equipment manufactured by Major Engineering Company. The agreement was announced jointly by Rainey Elliott, president of Jones & Laughlin Supply Division, and Ralph W. Hill, president of Major Engineering Company.

J&L is currently moving Major meter automatic custody transfer (MACT) units into stock at various J&L stores for immediate delivery.

W-K-M Moves District Sales Office to Dallas

The W-K-M Division of ACF Industries, Incorporated, has moved its Mid-Continent District sales office from Shreveport, La., to Dallas.

William E. Giffhorn, manager of the Mid-Continent District also has transferred to Dallas. Charles R. Shumate, who handled the sales of W-K-M products in the Dallas-Fort Worth area, has been appointed sales representative for company's International District. Shumate will make his headquarters at the home office in Houston.

USI Consolidates Axelson And Garrett Divisions

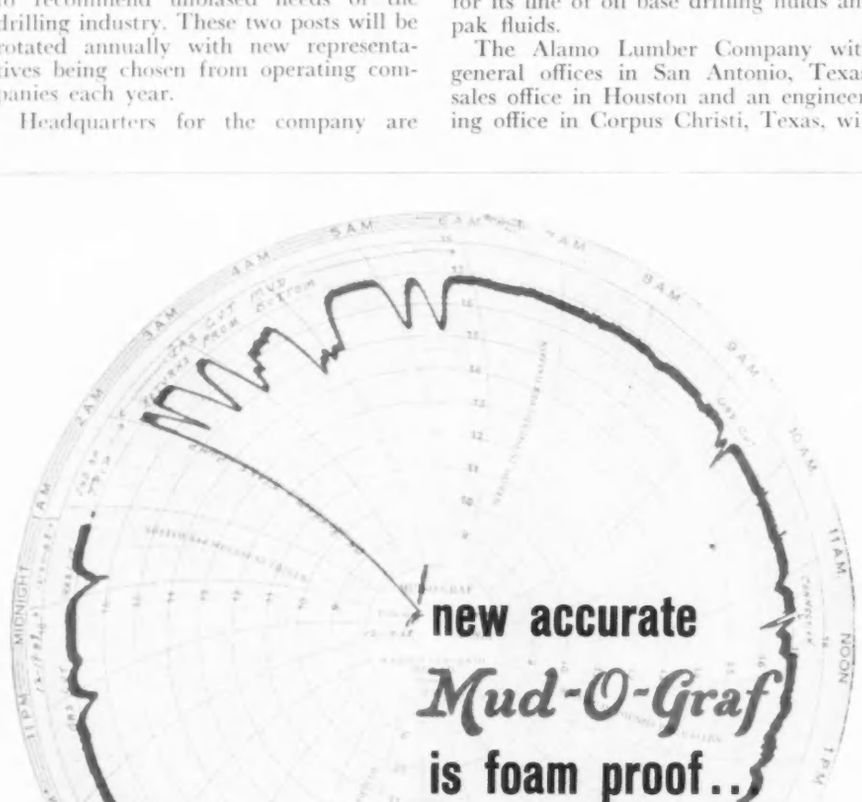
The consolidation of the two major oil and production equipment divisions of U.S. Industries, Inc., has been announced by John I. Snyder, Jr., chairman and president. Involved in the consolidation are USI's Axelson Division of Los Angeles and St. Louis and its Garrett Oil Tools Division of Longview, Texas.

Axelson and Garrett will be consolidated into one major USI operation to manufacture, sell, service and distribute all USI oil and gas production, transmission and allied equipment.

The division will have headquarters in Longview. It will be known as the Axelson-Garrett Division. Taylor Milton, now president of the Garrett Division, will be president of Axelson-Garrett.

Prompted by the similarity of both operations, the consolidation will result in substantial efficiencies and improvements in manufacturing, sales and service, according to company officials.

In addition to the new Axelson-Garrett plant in Longview, the division will maintain manufacturing facilities in Houston and in California and Missouri.



More than 1 million tons of mud have been weighed by Mud-O-Graf. This experience has led to the new, foam-proof, lost circulation-proof model.

A complete cycle of weighing is made every 45 seconds. The weighed sample is completely flushed out and passes over the shaker before the next fresh sample is taken.

The recorder can now be installed on the derrick floor without adverse effects from rig vibration on either its remarkable accuracy or its general operation.

Twenty years of experience in the mud weighing business has proved that there is no substitute for a completely accurate, continuous chart record of mud weight *placed in front of the driller*. Check these features:

- A weighing unit that will handle lost circulation material or foamy mud.
- The sample is taken every 45 seconds directly from the mud stream and is not dependent on pumping to a remote location.
- Each sample is completely flushed.
- The weighing unit is smaller and easier to maintain.
- Continuous recording on a circular chart, where a full twenty-four hours is visible to the driller.
- Recording is easily readable and accurate to 1/2 of 1/10 pound per gallon.

WARREN AUTOMATIC TOOL CO.
3915 THARP STREET • HOUSTON, TEXAS
Phone CApitol 4-2511

Lake Charles HEmlock 6-2265 | New Iberia EMerson 9-9862 | Harvey FOrest 6-1441

Once Was Enough

A worker got a dollar too much in his pay envelope and said nothing about it. The pay master discovered the error later and deducted a dollar the following payday.

"Say, I'm a dollar short," the worker said promptly.

"Well, you didn't complain last week when you were a dollar over," the paymaster spoke up.

"I know. But a guy can overlook one mistake. When it happens a second time, I complain."

No Place Like Home

"Dear, for some reason you don't seem as well dressed as you did when we were first married."

"I don't know why not. I'm wearing the same suit."

A Real Hard Worker

Personnel Manager interviewing new job applicant: "What have you done?"

Job Applicant: "About what?"

It'll Never Happen

This is supposed to have happened at one of the Senate investigating sessions. After a man who was to be questioned took his oath and sat down, the chairman inquired, "Have you a lawyer?"

The man declared, "No sir. I decided to tell the truth."

It Was a Great Life

It's hard to believe our nation was founded to avoid taxation.

Ye Ole College Days

A fraternity sent its curtains out to be laundered. The next morning a note arrived from the sorority across the street. It read:

"Dear Sirs: May we suggest you procure curtains for your windows? We do not care for a course in anatomy."

The immediate reply from the fraternity said:

"Dear Girls: The course is optional."

Say, Man . . . Like . . . Ah—

Two beatniks were traveling in Russia and saw a man being flogged in a public square.

"I don't dig that beat man," said one, "but dig that crazy drum."

There's No Place Like Home

A traveling salesman walked into a restaurant one morning and told the waitress, "Bring me two eggs fried so hard they are edged in black, two slices of burnt toast and a cup of cold coffee. Then sit down and nag me—I'm homesick."

Time to Change

Girl: "You play beautifully. Why did you take up the piano?"

Pianist: "My beer kept falling off my violin."

Facts on Sputnik

The entire Sputnik program cost the Russians 53 billion rubles and Sputnik is operated entirely by electricity. The cost of Sputnik and its rocket was 3 billion rubles. The remaining 50 billion rubles went for an extension cord.

The Last Word

"Did you give your wife that lecture on economy you talked about?"

"Yes."

"Any results?"

"Yes, I've got to give up smoking."

Just Growin' Up

Mother: "Sonny, don't use such bad words."

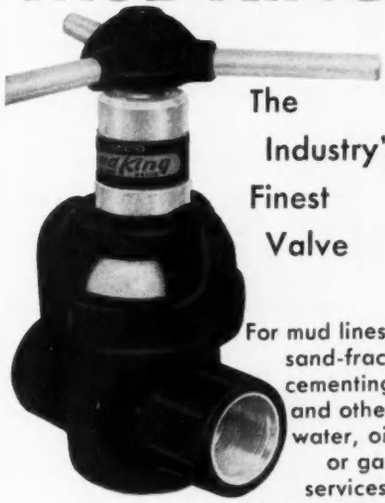
Sonny: "Shakespeare used them."

Mother: "Well, don't play with him."

So We're Progressing?

It seems incredible! Thirty-five million laws and no improvement on the Ten Commandments.

DEMCO
"MUD KING"®



The Industry's Finest Valve

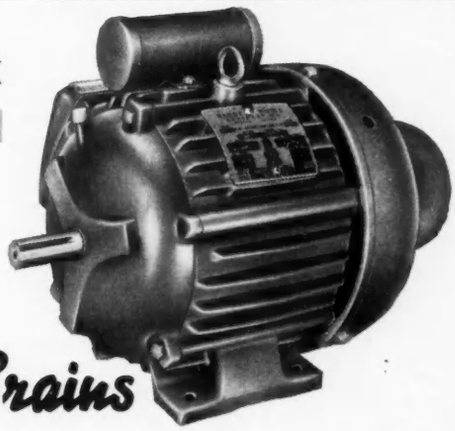
For mud lines, sand-frac, cementing and other water, oil or gas services.

Sizes: 2, 3, 4 inches
2,000 lbs. W.P. (4,000 lbs. test)
3,000 lbs. W.P. (6,000 lbs. test)

AT SUPPLY STORES EVERYWHERE

DRILLING EQUIPMENT MANUFACTURING CO.
DEMCO
845 S.E. 29th • Oklahoma City, Oklahoma

this new Brook totally enclosed fan cooled, single phase motor has



Brawn and Brains

The BRAWN is in the rugged design, producing cool operation and long service life and in the housing, which keeps out dust and moisture . . . and the external fan which blasts cooling air over the heat dissipating fins on the housing.

The BRAIN is in the external centrifugal switch which positively disengages when motor has attained pre-set speed. Switch is on outside of motor for accessibility . . . just remove cap. No need to disassemble the motor or remove it from line for switch repairs. Same switch fits all sizes of motors . . . 1 to 5 HP.

You get real economy where dust, fumes or moisture are a problem. Dealers everywhere. Send for literature.

"World's Most Respected Motor"

BROOK MOTOR CORPORATION
3302-04 W. PETERSON AVE., CHICAGO 45, ILL.
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SECONDARY RECOVERY

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RESERVOIR ENGINEERING
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EVALUATION CORE ANALYSIS
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Cost Estimates, Design, Installation
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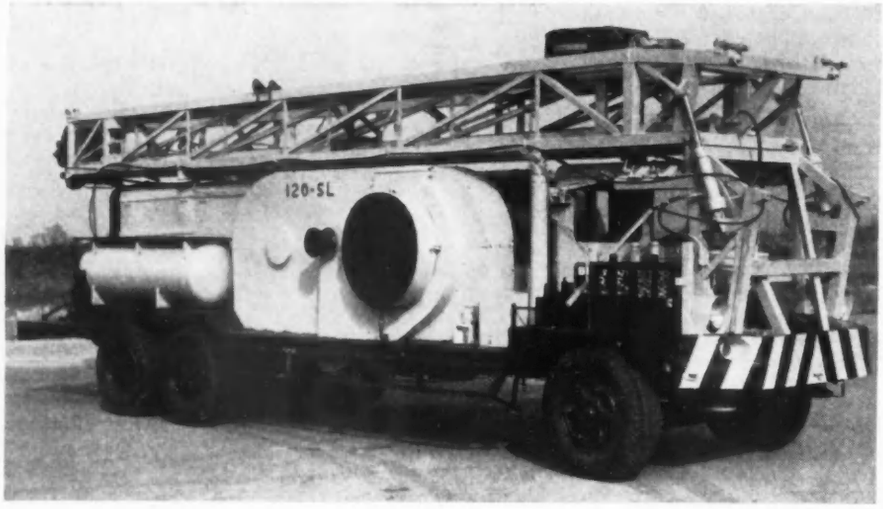
Phone 723-2167

For more data on advertised products, use Readers' Service Cards, last page.

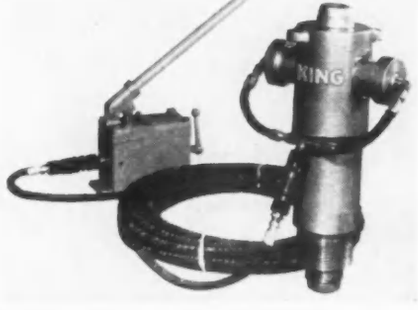
NEW equipment and services



Mobile Well Servicing Rig

This new lightweight mobile servicing rig, Model 120-SL, is designed for well service and rotary workovers to 12,000-foot depths. Features include: Rugged compact drive-in type construction with power steering; air brakes; complete road visibility and comfortable one-man cab; grouping of controls at operator's station; 9-speed forward, 2 reverse, fully-synchronized transmission with air assist shift and remote control. (Bucyrus-Erie Co. Supplements data on Pages 937-941, 1960-1961 Composite Catalog).

For more data, circle E1 on postcard



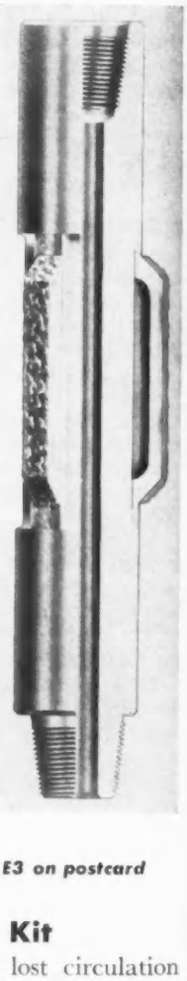
New Wire Line Stripper

A new wire line stripper, the HAR, which is hydraulically operated and features the exclusive King auto-release mechanism is now available. Unit can be operated from the derrick floor and is recommended for use in swabbing tubing, wire line coring, sidewall sampling, well logging and other wire line operations. It has a positive latch and the HAR will not release by accident, yet, auto-release mechanism is activated by the rope socket striking the bottom of the stripper. (King Oil Tools. Supplements data on Pages 3141-3164, 1960-1961 Composite Catalog.)

For more data, circle E2 on postcard

Stabilizer—String Reamer

A number of advantages are claimed for the Hunt Combination Stabilizer and String Reamer. At low initial cost, this tool with replaceable blades provides: More weight on the bit at faster rpms, straighter holes when spaced at intervals above the bit, controlled deviation when used as fulcrum tool directly above bit, elimination of sharp bends and keyseats, insurance against "wall sticking," and hollow blades for each washover. (Hunt Tool Company. Supplements data on Pages 2713-2760 & 1848A-1848D, 1960-1961 Composite Catalog.)



For more data, circle E3 on postcard

Lost Circulation Kit

Development of a lost circulation kit designed to explain the functioning of lost circulation materials in oil well drilling operations has been an-

W. C. NORRIS

Field Tested and Approved
150 psi working pressure

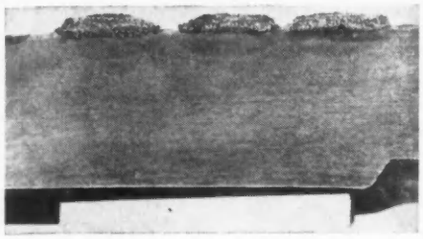
WRITE FOR NEW VALVE BULLETIN
P. O. Box 1739, Tulsa

VALVES

New equipment

nounced. Kit consists of 10 basic lost circulation materials, a graphic illustration of a geologic subsurface cross-section, a listing of the product applications and directions for correlating the product uses with various types of lost circulation zones encountered in oil well drilling. (Magnet Cove Barium Corp., One of the Dresser Industries. Supplements data on Pages 3455-3462, 1960-1961 Composite Catalog.)

For more data, circle E4 on postcard



Tungsten Gas-Shielded Method

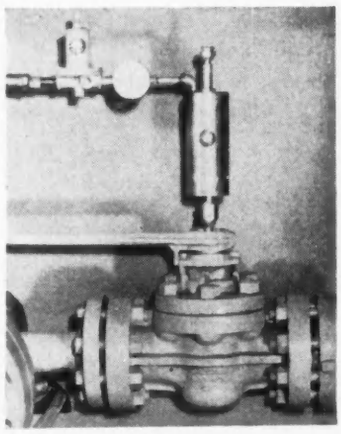
This tungsten inert gas-shielded method, known as the Hunt-Cullum Process, has been introduced as a method for hard-banding tool joints and drill collars in the field. Advantages provided: Insures that the optimum amount of tungsten carbide particles is distributed throughout the weld deposit; insures a uniform quality hard-facing band with particles of tungsten carbide in their original form evenly distributed throughout the thickness of the deposit; insures rapid, uniform deposit by automatic machinery. (Hunt Tool Co. Supplements data on Pages 2713-2760 & 1848A-1848D, 1960-1961 Composite Catalog).

For more data, circle E5 on postcard

Fiberglas Outer Wrap

Fiberglas Outer Wrap for the protection of underground pipe lines is now available. It is inert, resistant to impact and soil stress and is not affected by acids and fungus. Designed to cover both hot and cold applications, it will not stretch unduly, shrink, sag or rot underground. The new outer wrap will not absorb soil moisture and it is immune to soil acids and electrolytic action. It will not attack the protective enamel or wick-out the oils of the saturants. (Owens-Corning Fiberglas Corp.)

For more data, circle E6 on postcard



Automatic Lubricator

A new automatic valve lubricator, designed to provide lubricated plug valves with a continuous and regulated supply of lubricants, is now available. Lubricator is applicable for remote valve installations where controlled and automatic lubrication is necessary. It is adjustable and can be set to furnish lubricant only when the valve requires it. There is no waste. (Rockwell Manufacturing Company. Supplements data on Pages 4733-4776, 1960-1961 Composite Catalog).

For more data, circle E7 on postcard

No-Wall-Stick Drill Collars

The surface area of these drill collars has been changed to reduce wall contact area by more than 40%. Weight loss of the drill collar is only about 4%. Reduction of 40% in contact area results in a proportionate decrease in the total sticking force due to differential pressure of 40%. This design also gives a section of pressure equalization each foot along the body of the drill collar.

Three sizes (6", 4¾", 4⅛") of NO-WALL-STICK DRILL COLLARS are available on a rental basis in the Texas and Louisiana Gulf Coast area. Rental price of these NO-WALL-STICK DRILL COLLARS is very competitive to conventional drill collars run with stabilizers.

Any new or used drill collars, regardless of size, owned by Drilling Contractors or Oil Companies may be converted to NO-WALL-STICK DRILL COLLARS for a fixed conversion charge.

NO-WALL-STICK DRILL COLLARS offer far more protection from wall sticking in high angle holes or holes which have shale wash outs than drill collar strings using stabilizers.

NO-WALL-STICK DRILL COLLARS will not ball up, will not peel off wall cake, and may be sealed off by a Hydril type blow out preventor at any point.

Patent Pending

FELDCO ENGINEERING LABORATORIES FOR DRILLING

ENGINEERING ENTERPRISES, INC.

HOUSTON, TEXAS

San Jacinto Bldg. Houston, Texas

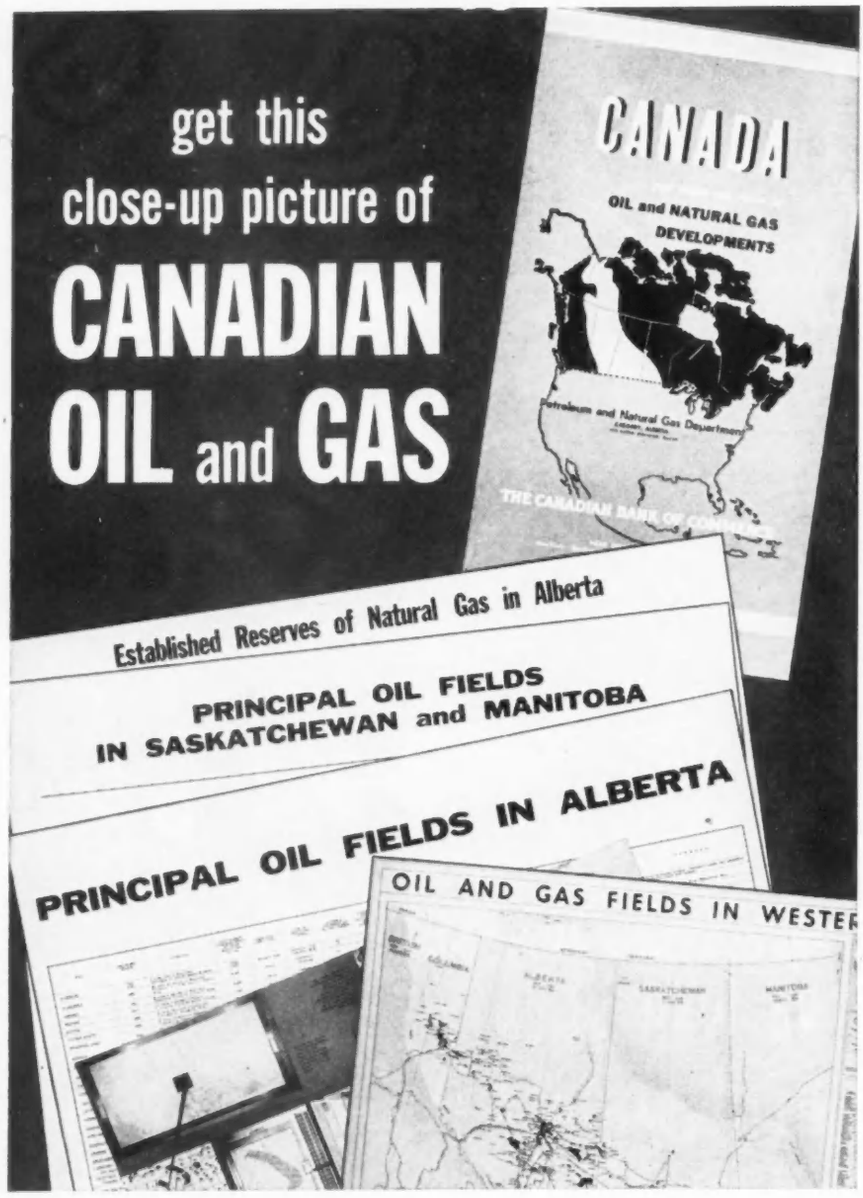
304 Kim Drive Lafayette, Louisiana • CE 4-4607

No-Wall-Stick Drill Collars effectively reduce sticking of drill collars

This new drill collar design has been expressly developed to combat the problem of differential pressure sticking of the drill collar string in the hole. It is a direct step in materially reducing the total sticking force.

Please write Houston office for descriptive brochure and price schedules

No-Wall Stick Drill Collars may be handled through your local rental tool company.



With a Petroleum and Natural Gas Department in Calgary staffed with technical men, and with nearly 300 of our branches located in Western Canada and the Northwest and Yukon Territories, we are in continuous touch with Canada's oil and gas developments. For information on any phase of the Canadian petroleum industry, please send your letterhead request for our complete and up-to-date review of developments. It contains our latest map, statistical data on the principal Canadian oil and gas fields, and a summary of the special services we offer to the industry.

Address your inquiry either to

Petroleum and Natural Gas Department
The Canadian Bank of Commerce
309 Eighth Avenue West
Calgary, Alberta, Canada

or to

Mr. John P. Moreton
Resident Representative
The Canadian Bank of Commerce
1512 Commerce Street, Dallas, Texas

We do not advise regarding speculative securities.

In Canada, it's—

THE CANADIAN BANK OF COMMERCE

Head Office: Toronto 1, Canada

New York • San Francisco • Los Angeles • Seattle • Portland, Ore.
Resident Representatives—Chicago, Ill. and Dallas, Texas
European Representative—Zurich, Switzerland
More than 850 branches across Canada

New equipment

Washover and Recover Cutter

A new washover and recover cutter which has reduced fishing times as much as 50 percent or more as compared to time required to washover and retrieve stuck drill pipe and tubing by conventional method is now available. Advantages: Saves rig time, only one operator required, recovers up to 2,000 feet of pipe in single run, depending on hole conditions, and eliminates handling of washpipe between cuts. (Hunt Tool Company. Supplements data on Pages 2713-2760 & 1848A-1848D, 1960-1961 Composite Catalog.)

For more data, circle E8 on postcard

Lost Circulation Material

Plasti-Plug is a granular lost circulation material made of an engineered blend of thermoplastic and thermosetting plastics, each individually selected for its special properties. It is produced in medium and fine grade. Plasti-Plug will last indefinitely in the mud system and additions need be made only when the mud volume is increased or the lost circulation material has been consumed in sealing loss zones. (Cherokee Laboratories, Inc.)

For more data, circle E9 on postcard

Du Pont offers "Qualex"...

TRADEMARK

...a highly refined grade of CMC to help you solve most drilling mud problems

Du Pont "Qualex" is *over 99.5% pure.*

This highly refined grade of CMC is now available to help you solve drilling mud problems that demand the very highest in purity. It will give you maximum effectiveness in controlling mud viscosity and fluid loss in the hole.

And to help you further improve drilling efficiency, "Qualex" is available in two viscosity types:

High Viscosity "Qualex" promotes faster drilling rates by minimizing the quantity of clay solids required to maintain the desired mud viscosity.

Low Viscosity "Qualex" gives maximum reduction in fluid loss with a minimum effect on viscosity as required in heavily weighted mud systems.

Du Pont's complete line of CMC types and grades is your answer to widely varied mud problems.

FOR MAXIMUM PURITY

Du Pont "Qualex" grade CMC—High Viscosity

Du Pont "Qualex" grade CMC—Low Viscosity

Your mud dealer can give you immediate delivery of either the "Qualex" refined grade or "DM" technical grade of Du Pont CMC. Call him, or get in touch with Du Pont, Explosives Department, 6539 Nemours Building, Wilmington 98, Delaware.

Branch Offices

3202 Weslayan St.
Houston 27, Texas
Phone: MOhawk 7-9197

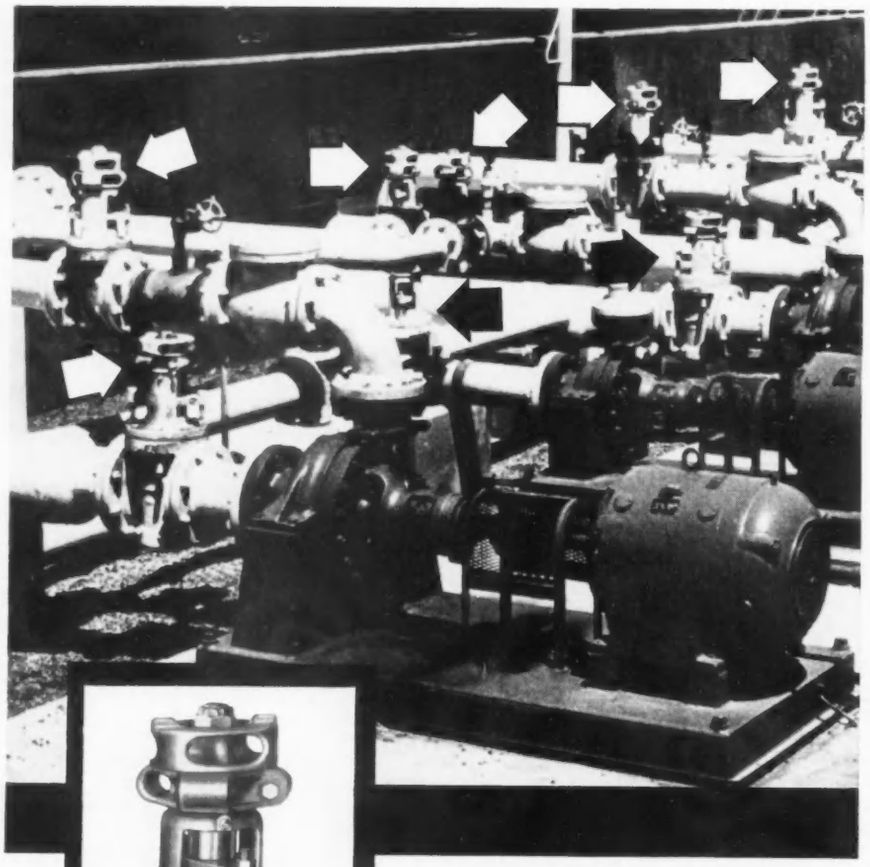
2930 East 44th Street
Los Angeles 58, California
Phone: LUdlow 2-6464

DU PONT CMC

DU PONT

REG. U.S. PAT. OFF.

Better Things for Better Living
...through Chemistry



Eliminate the expense and trouble of valve lubrication with

HAMER PLUG VALVES

Hamer Plug Valves are unsurpassed for sure sealing, ease of operation and low maintenance cost. Being non-lubricated they not only eliminate the cost of lubrication but also prevent contamination of line product. The powerful plug adjusting nut acting as a screwjack is a positive means of raising and lowering the plug when operating the valve.

The plug and body seats are finished on special grinding machines and individually matched for precision fit, assuring smooth operation and perfect sealing.

Hamer Plug Valves are available in sizes 2" through 12" in working pressures to 600 lbs. W.O.G. Ask your Hamer Valve Specialist for complete specifications and applications of Hamer Plug Valves. Write for new catalog.

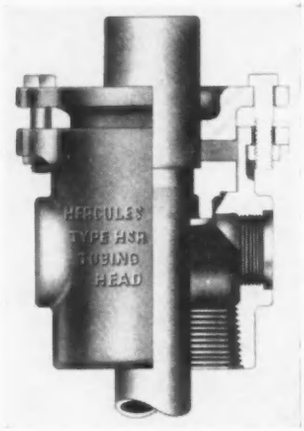
WECO

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

HV-3-60

fmc

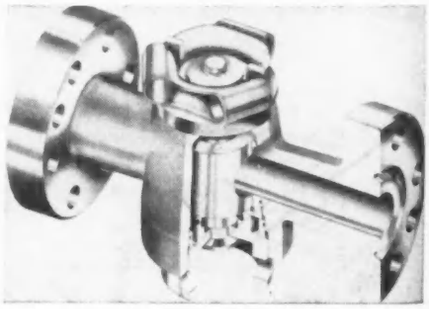
New equipment



New Tubing Head

A new collar-suspension tubing head, Type HSR Tubing Head, is now being marketed for use on tubingless completions, waterflood and shallow pumping wells of 2,500 feet depth or less. It is available in 3½-inch OD, 4½-inch OD or 5½-inch OD female casing sizes. The 3-inch size body, with 3-inch minimum bore, suspends ¾-inch to 1½-inch plain or EUE tubing. Test pressure is 500 psi and maximum recommended load is 30,000 pounds. (Hercules Tool Company. Supplements data on Pages 2463-2498, 1960-1961 Composite Catalog.)

For more data, circle E10 on postcard



Lo-Torq Plug Valves

These Lo-Torq Plug Valves have been designed to help fill needs encountered in performing service work and are available in a variety of sizes and equipped with flanged-ends. Requires minimum effort of operation and is used in all phases of the oil industry. Provides long, low cost operating life with a minimum of maintenance. Need for returning valves to factory is eliminated since there is no necessity of matching parts. (Halliburton Company. Supplements data on Pages 2301-2424, 1960-1961 Composite Catalog).

For more data, circle E11 on postcard

A COMPLETE PACKAGE

Development of Welex's Acoustic Velocity Log adds a sparkling new service to the Welex Simplified Logging Program.

Formerly effective in 90 percent of today's wells,Welex's Simplified Program, with the addition of the Acoustic Velocity Log, now can give the best answers available in EVERY WELL—even the more complex, difficult-to-analyze wells.

The Acoustic Velocity Log accurately determines porosity by measuring the velocity of sound traversing formations. It also is useful to geophysicists for interpretation of seismic records.

As with the Welex FoRxo and Neutron Logs, porosity values can be read directly off the Welex Acoustic Velocity Log. When run in conjunction with the Welex Induction or Guard Log, the most important question—WILL THE WELL PRODUCE?—can be answered in minutes by use of the Simplified Interpretation Charts, or "pigtails," printed right on the log.

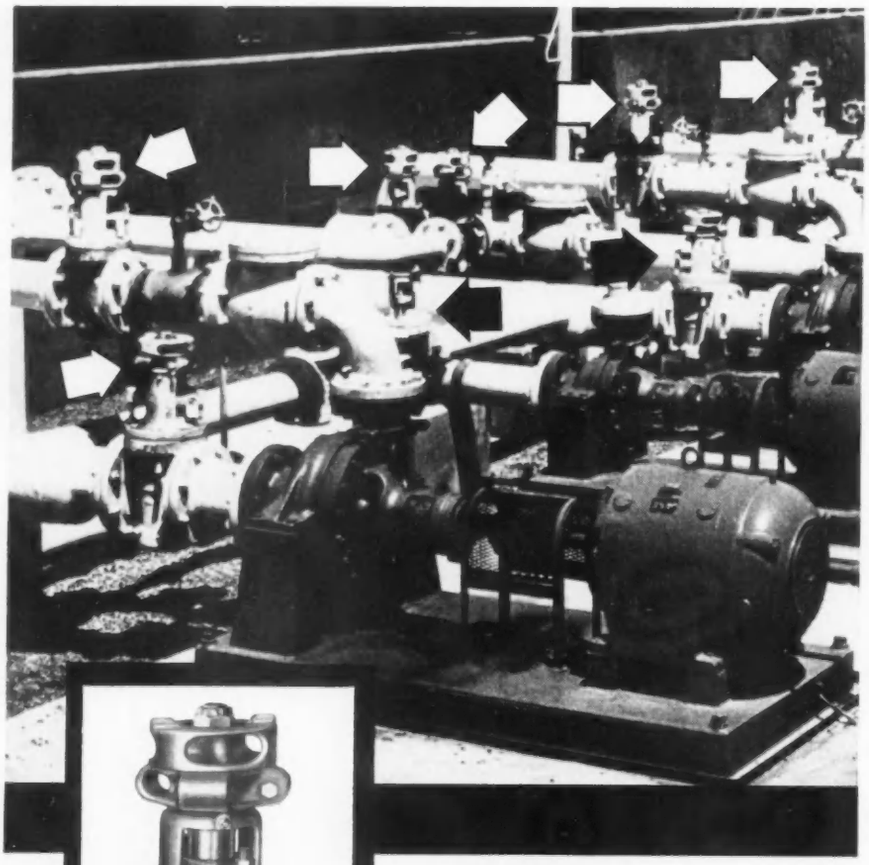
Most effective in formations with intergranular porosity, the Welex Acoustic Velocity Log can be run jointly with a self potential curve, gamma ray curve or caliper log for correlation purposes.

Next time and every time call your nearest Welex representative for the complete package of logging services that will answer the most important question—WILL THE WELL PRODUCE?

ORIGINATORS OF Welex JET PERFORATING

WELEX, INC.

General Offices: 1400 East Berry, Fort Worth, Texas
In Canada: Welex of Canada, Ltd.



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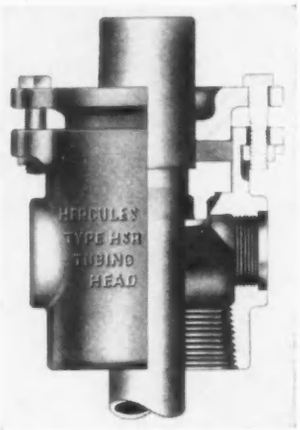
HOUSTON, TEXAS
Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

HV-3-60

fmc

WECO UNIONS | CHIKSAN SWIVEL JOINTS | HAMER LINE BLIND VALVES | HAMER PLUG VALVES

New equipment



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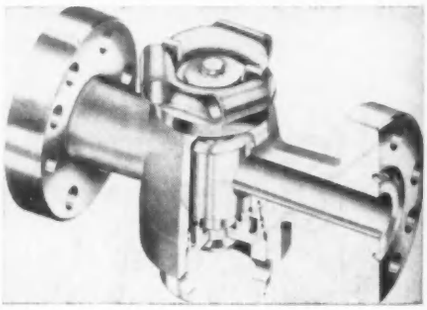

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ORIGINATORS OF Welex JET PERFORATING

WELEX, INC.

General Offices: 1400 East Berry, Fort Worth, Texas
In Canada: Welex of Canada, Ltd.

Developed and now patented by Hycalog . . .

V-DOOR DRILL BITS

U. S. Patent No. 2,931,630

CORE AND BUST TO ACHIEVE LONG UNINTERRUPTED RUNS

Diamond drill bits were formerly handicapped in duration of runs . . . *and rate of penetration* . . . by their inability to dispose of cores formed at their centers.

In shales and other soft formations, the core twisted off and rotated with the bit.

In hard sands the core crushed the center diamonds, preventing further drilling.

BUT HYCALOG'S ENGINEERS have turned these handicaps into an advantage. Now, the V-DOOR bit, developed by HYCALOG, utilizes *controlled failing* of cores to achieve a faster rate of penetration . . . *and longer life.* HERE'S HOW:

The diamond surfaced center hole purposely cuts a cylindrical core. Valve action of core against bit reduces escape of fluid through the V-DOOR . . . forces it over the cutting surfaces keeping them thoroughly flushed.

Combination of bit design and hydraulic pressure breaks core into short segments. Then valve action is momentarily interrupted; high pressure fluid is released with a surge into V-DOOR port, forcing core fragments into discharge port.

Core fragments are flushed out of hole. With every revolution, the V-DOOR port sweeps bottom of the hole removing loose small particles, and eliminating necessity of regrinding.

Ask your HYCALOG rep to show you some performance records on the V-DOOR. He has a stack of them. *And also get the facts on* HYCALOG *well logging.*

Hycalog, Inc.

505 AERO DRIVE

SHREVEPORT, LOUISIANA

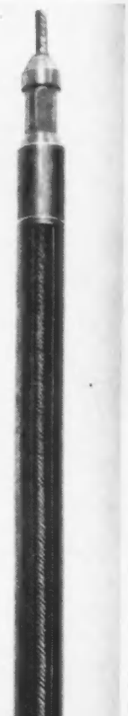
BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND CORING • DIAMOND BITS • WELL LOGGING • CORE ANALYSIS

New equipment

Releasing Rope Socket

The Bowen Releasing Rope Socket was designed to permit use of the full strength of the wire line during a swabbing operation, yet give immediate and positive release when the swab becomes stuck due to debris in the well. Rope Socket is, in effect, a swabbing line safety joint, allowing full use of the ultimate strength of the line and, at the will of the operator, assuring positive release and removal of the wire line from the hole, leaving it clean, sure fish to engage and recover. (Bowen-Itco, Inc. Bowen Kinzbach. Supplements data on Pages 713-828 & 3165-3184, 1960-1961 Composite Catalog).



For more data, circle E12 on postcard

Plastic Pipe

A new plastic pipe designed for oil field service is made of "Delrin" acetal resin, a new major plastic for use in many applications traditionally served by metals. Unique advantages is a simple heat-fusion fastening method which yields an integral joint of high strength. (E. I. du Pont de Nemours & Company).

For more data, circle E13 on postcard

Photo Courtesy Standard Oil Co. (N. J.)

Nickel alloy steels give you rock bits that withstand impact...abrasion...stress

After the string has been run in, it'll be a long time before this rock bit sees Texas daylight again.

Meanwhile, cutting through thousands of feet of hard, dense formations, the bit will meet severe abrasion, high stresses, heavy impact.

To survive this punishment and keep drilling costs down, rock bits need the strength and toughness of a nickel alloy steel.

Here are two nickel steels, readily heat-treated to produce a wear-resisting case, backed up by a tough core to stand repeated shock-loading.

The logical choice for the toughest drilling is AISI 4820, a case-hardening steel containing 3½% Nickel. Rock bits made with 4820 develop the high core properties needed for cutting through the hardest compact formations.

For fast, straight penetration in moderately hard formations, AISI 4615-20 carburizing steel (1.85% Ni) provides good core properties for long drilling life in all but the most severe applications.

Both these steels are noted for reliable, low-distortion response to heat treatment.

Next time you order rock bits, remember that nickel alloy steels mean more hole per bit . . . fewer round trips . . . *lower drilling costs.*

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES STEEL PERFORM BETTER LONGER

New equipment

Lost Circulation Material

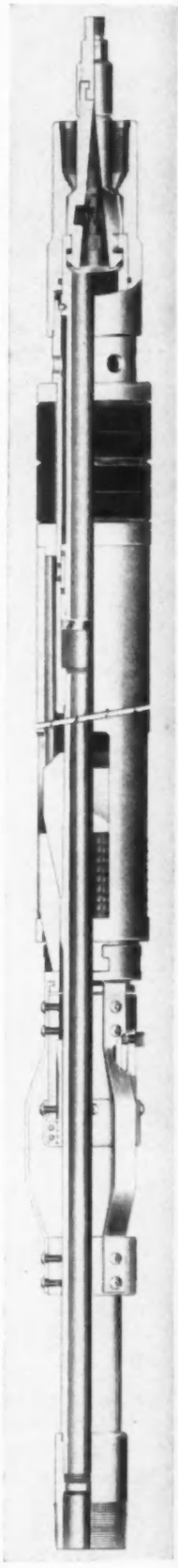
Poly-Plug is an engineered homogeneous mixture for the prevention and control of lost circulation. Consists of ground and graded granular plastic, ground and graded hard nutshell and high strength inert fibre. Poly-Plug is now being offered in the coarse (maximum particle size one-fourth inch) grade only. (Cherokee Laboratories, Inc.)

For more data, circle E14 on postcard

Circulating Packer

A new circulating packer is now being marketed by the manufacturer. The VP Packer is a hook wall type with a built-in sleeve valve that permits circulation of the fluid in the casing annulus when the packer is set. Valve in the new VP Packer is opened and closed with wire line tools. Can be set by conventional top hole manipulation and by applying a portion of the tubing weight to compress the packing element. (Page Oil Tools, Inc. Supplements data on Pages 4369-4388, 1960-1961 Composite Catalog.)

For more data, circle E15 on postcard

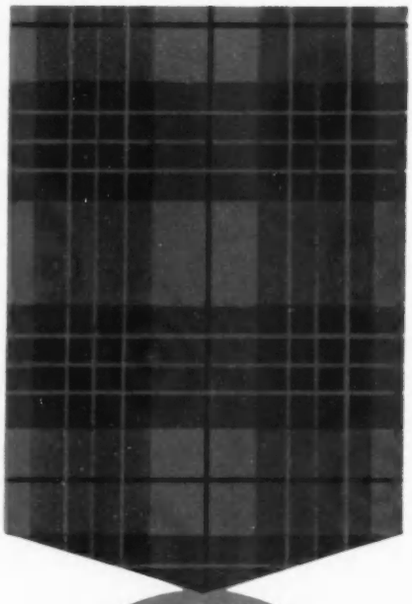


Time Switch

A new multi-control time switch for pumping control in oil fields is now available. Unit permits different groups of wells to pump each day, with individual programs for each group. Units are available in special outdoor housings, or, with bracket alone for panel mounting. (Tork Time Controls, Inc.)

For more data, circle E16 on postcard

WINNING COMBINATION by McKISSICK



WIDEST POSSIBLE RANGE OF SIZES AND CAPACITIES — UNBEATABLE MCKISSICK CONSTRUCTION — EXTRA HEADROOM, SHORT OVER-ALL LENGTH. CENTER PLATES BETWEEN EACH SHEAVE.

EXTRA WEIGHT FOR BALANCE . . . JOHNS-MANVILLE "KLIPPER" GREASE SEALS.

EXTRA LARGE BEARING DIAMETER, E-Z OPENING GUARDS. NO BOLTS TO REMOVE. 17" TO 42". O. D. ALLOY STEEL FLAME HARDENED SHEAVES. BUILT IN "BUMPER".

BE SPECIFIC . . .
GET McKISSICK!

McKISSICK

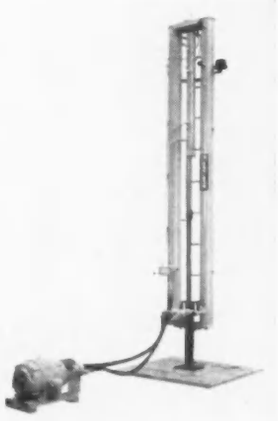
McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

New equipment

Tubing Head Assembly

The new MACCO-type SH tubing head assembly was designed and developed for slim hole and tubingless completions where durable, yet economical, well head equipment is required. Rated at 4,000 psi working pressure, it consists of a tubing hanger, wing nut union and tubing head with two outlets, standard 1½ and 2-inch line pipe. (Macco Oil Tool Co., Inc. Supplements data on Pages 3448-3450, 1960-1961 Composite Catalog).

For more data, circle E17 on postcard



New Hydrax Unit

Recently developed and made available is this new surface 36-inch stroke hydraulic pumping unit. It is available in two polished rod load capacities, 3,500 and 5,000 pounds. Units are complete, including a direct drive electric motor or a V-belt drive for internal combustion engines. Advantages: Ease of installation; simplicity of operation; cooler operation and external filter for ease of maintenance. (Axelson Division of U.S. Industries, Inc. Supplements data on Pages 269-340, 1960-1961 Composite Catalog).

For more data, circle E18 on postcard

The
H – G
DS* TUBING JOINT
Has Proved
Its Superiority as to
ECONOMY • CLEARANCE
PRESSURE HOLDING ABILITY
In Over
3,000,000 FT. OF TUBING

This streamlined integral connection is designed for applications where clearance is a problem in moderate depth wells. Its tremendous acceptance has resulted from the effectiveness of the Teflon† seal to hold pressures, its balanced streamlined design, and its reasonable cost.

Complete technical data and costs are available from the H-G salesman, or direct from the company.

HARDY-GRIFFIN
ENGINEERING CORPORATION
A Division of Atlas Pipe Inc.
14522 S. Main St., HOUSTON, TEXAS, Tel. GY 9-9250
Midland, Texas Odessa, Texas New Iberia, La.
Oklahoma City, Okla. Tulsa, Okla.

*Patent Pending
†Registered trademark of E. I. du Pont de Nemours and Co.

Here's how CONTINENTAL-EMSCO helps solve YOUR PURCHASING PROBLEMS...

PLANT — HOUSTON, TEXAS

PLANT — GARLAND, TEXAS

5 BIG PLANTS

throughout the world provide a NEW STANDARD of QUALITY and RELIABILITY . . to give you added confidence in purchasing oil field equipment.

At Continental-Emsco's Houston and Garland, Texas, plants, every step of engineering, production, quality control and final testing falls under the surveillance of one, at-the-plant, management. For you, this means:

(1) highest quality at lowest possible price

(2) faster delivery

(3) modifications made under exact design engineering control

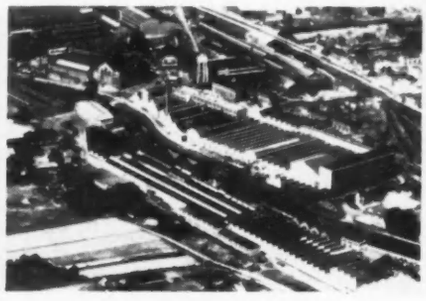
(4) compatible component parts

(5) units complete in every detail

(6) dependable field performance

Combine these domestic U. S. facilities with Continental-Emsco's worldwide manufacturing, sales and service organization and you have a NEW STANDARD for judging equipment and service dependability.

PLANT — ST. ALBANS, ENGLAND



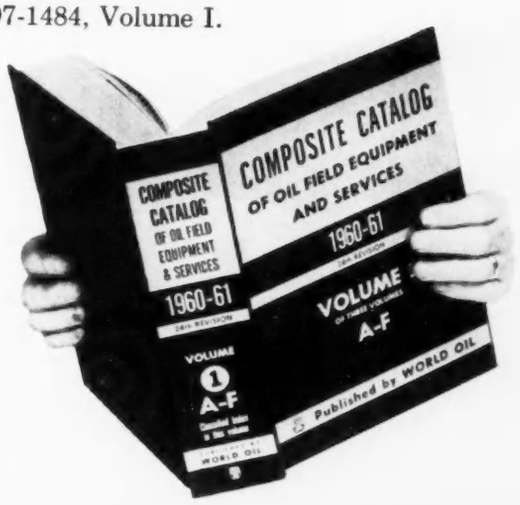
PLANT — S.N. MAREP, JEUMONT, FRANCE
(Licensee)

PLANT — NAVALMECCANICA, ITALY
(Licensee)

19 NEW ITEMS are included in Continental-Emsco's expanded section of the 1960-61 COMPOSITE CATALOG . . giving extensive purchasing data on Continental-Emsco equipment. See pages 1397-1484, Volume I.

- T-97 DUAL TRAILER DRILLING MASTS
- D-125 POWER SLUSH PUMPS
- D-225 POWER SLUSH PUMPS
- D-375 POWER SLUSH PUMPS
- D-550 POWER SLUSH PUMPS
- B-LINE DRILLING RIGS
- B-LINE ROTARY TABLES
- B-LINE TRAVELING BLOCKS
- B-LINE SWIVELS
- B-LINE POWER SLUSH PUMPS
- GREAT SEAL WASHDOWN HOSE
- UNIT PUMPERS TO NEW API STANDARDS
- GREEN TRIANGLE "CONVERTIBLE" ELECTRIC MOTORS
- CONTINENTAL NO. 8 SUCKER RODS
- CONTINENTAL SUCKER TUBES
- D+B CASING PUMPS IN ADDED NEW SIZES
- EXTREME LINE CASING*
- BUTTRESS THREAD CASING
- SLIM-HOLE ROTARY HOSE

*Produced under license from the National Supply Company



PARTS DEPOT — MORGAN CITY, LOUISIANA

134 EFFICIENTLY STAFFED CONTINENTAL STORES AND SALES OFFICES

. . conveniently located . . adequately stocked to back your purchasing decisions with the ultimate in service. Did you know Continental-Emsco covers the active oil fields of the world so completely that wherever you move your equipment, there's a Continental representative not far away? Through its international organization, you have uniform equipment and parts, maintenance and installation information and the fast service you need for economical operation.

Use your Continental-Emsco section of the Composite Catalog with confidence when ordering. Rely on Continental-Emsco's quality controlled manufacturing facilities for any and all of your equipment requirements. Make it a habit to buy from your conveniently located Continental stores and sales offices. Solve your purchasing problems the sure way . . the Continental-Emsco way!

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

CONTINENTAL EMSCO COMPANY
A Division of The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y.
Continental-Emsco Company Limited
General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela
Plants: Houston and Garland, Texas;
St. Albans, Herts, England
Representatives in All Principal Oil Fields of the World

CC 001